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The Sundarban of India and its biota[1]

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(*With a plate*)

Physiography

The Sundarban is a tropical humid forest belt that stretches from the Hooghly river (India) on the west to the Meghna river (Bangladesh) in the east. It spreads over the southern part of three districts, namely, 24 Parganas (India), Khulna and Backarganj (Bangladesh). The boundary of the Sundarban within West Bengal is demarcated by the Raimangal and Hooghly rivers in the east and west respectively, and the Bay of Bengal in the south. The northern limit cannot be clearly defined due to progressive reclamation of the land over the last 150 years. The area lies approximately between 21° 0′-21° 21′ N and 88°0′-89°0′E.

The forest spreads over the Gangetic delta which is low, flat and alluvial, and is intersected from north to south by several wide rivers, numerous sluggish winding creeks and is interspersed with lagoons. The water in these creeks, pools and rivers is saline. The humid forests

[1] Accepted August 27, 1971.

which grow on such delta is known as 'mangrove swamps' and such forests stretch for about 240 kilometres (150 miles) from west to east and are approximately 48 kilometres (30 miles) wide. Out of 11520 sq. kilometres (4500 sq. miles) the total forest area of 4096 sq. kilometres (1630 sq. miles) is now under Indian administration. Of this area, 2320 sq. kilometres (997 sq. miles) are covered with forests and the rest is water (Mitra 1954). The principal rivers of the area have a general north-south course towards the sea. Some of these rivers join and lead to the estuaries, namely, Hariabhanga, Gusaba, Matla, Thakuran, Saptamukhi and Muriganga. The principal rivers which open into the estuaries by traversing the Sundarban from east to west are Kalindi, Raimangal, Jhilla, Gusaba, Bidya, Matla, Thakuran, Saptamukhi and Baratala. They are tidal rivers and receive three tides a day. The difference in the water levels between high and ebb tides varies from six metres (20 feet) to 20 centimetres (8 inches) depending on the phase of the moon.

The estuarine islands of the Sundarban from east to west are Bangaduni, Dalhousie, Halliday, Bullcherry, Lothian, Farserganj (Buckleenberg). Numerous islands in the estuaries are still under formation.

The formation of alluvial surface and the alteration of river courses in Lower Bengal has been discussed in detail by Oldham (1893). The meandering action of rivers in the low lying Sundarban area helps in the creation of innumerable islands. The silt and loam brought down by the rivers from the north and poured on to the continental shelf undergo partial transformation due to exchange reactions with sea water (Raychoudhuri *et al.* 1963, p. 51). These constituents remain in suspension and are forced into the creeks, channels and rivers by high tides. The constituents in suspension settle down due to gravitational force and are deposited on the bed and the salinised soil is gradually covered with mould. After the soil is stabilised, further deposition of alluvium helps in elevating the edges which give rise to a natural embankment and a saucer-shaped depression is formed inside where in the course of time signs of life become visible when the monsoon rains wash the salinity off the place. Some shrubs and trees take root and gradually a dense forest flourishes in a place which once was under water.

The soil of the Sundarban is generally clayey loam and grey to greyish-black in colour. Sandy and alkaline soils are found on islands facing the Bay and at many degraded places on the surface. Raychoudhuri *et al.* (op. cit., p. 40) gave the composition of the low lands of the 24-Parganas district as follows: 'The soils in general are deficient in nitrogen which ranges from 0.02 to 0.09 per cent. The soils respond to application of nitrogenous fertilizers and give a yield increase of about 240 lbs. per acre. The phosphate in the soils varies from 0.1 to

0.15 per cent in the riverine and flat lands, and 0.06 to 0.1 in low lands. The pH of this soil ranges from 7.0 to 8.0 and potash varies from 0.3 to 1.0 per cent in the riverine and flat lands. Calcium oxide in the riverine and flat lands is high, ranging from 1.0 to 5.0 per cent.'

The soils of the Sundarban may be classified into four main categories:

1. *Matial*: Clayey soil, whitish, loose and light in composition. When reclaimed it is rich in plant nutrition and supports a good cultivation. It is also rich in calcium and magnesium and partially decomposed matter.

2. *Baliara* or *Dorosa*: Loamy soil reddish in colour, retains moisture longer than the other three types of soil. Coarse paddy may be grown.

3. *Dhap*: Whitish soil, lies at higher levels than other classes. Salt is not washed off. This is degraded alkali soil and, therefore, only such coarse vegetation as thatch grass (*Ulu*), grows on it.

4. *Dhal*: Found on newly formed islands which get flooded either due to high tide or due to rain water. The soil is reddish in colour and cracks when dry. Nothing substantial grows on such land.

The rivers of the Sundarban are subject to tidal influence and are, therefore, saline. The rivers between Raimangal and Matla in the east and Muriganga and Hooghly on the west receive fresh water from the Ichhamati and Hooghly respectively, so that their salinity is greatly reduced. The increase in the salinity of the rivers of the western Sundarban appears to be a recent phenomenon, which is evident from Major Rennel's atlas of 1781 and Morrieson's of 1811; in both some villages are shown along the Sundarban rivers where today only dense forests exist. Those villages had evidently been abandoned by later increase in the salinity of the adjacent rivers leading to failure of agriculture.

Extreme climatic conditions do not prevail in the Sundarban. The network of creeks and rivers and the nearness of the Bay help in controlling the extreme climate. A typical tropical monsoon climate with excess of humidity is prevalent for about six months of the year, the day being moderately warm, equitable and humid, and there is a slow increase in the night temperature. The cold weather prevails from November to January and the rainfall during the period is negligible (mean of these three months is 2.5 cm). The mean maximum temperature for the years 1955-1960 is 30°C and the minimum 15°C. The temperature begins to rise from February and February, March and April are comparatively dry. Occasional thunder-storms accompanied by rains start from April. In May and October-November cyclonic storms occur. The cyclone causes high waves and combined with high tides frequently brings devastation to the area. The mean temperature

for six years (1955-1960 for February, March and April) is 31.8°C (maximum) and 26.6°C (minimum). The monsoon generally starts from the middle of June and continues till October, and the mean temperature slowly diminishes during the rainy season, but the humidity goes on increasing to 95 per cent. The total annual rainfall (average of the above-mentioned six years) is 265 cm and the average of the monsoon months for those six years is 230 cm.

Biota

Flora

The vegetation of the Sundarban may be broadly classified as (a) the sea-face (beach forests), (b) the formative island flora, (c) the flora of the reclaimed low-lying cultivated tracts, and (d) the swamp forests.

The present forest area covers about 2320 sq. kilometres (997.9 sq miles) of the delta. Special type of the marsh vegetation composed of elements mainly of the Malay Peninsula and Polynesian regions, together with some Indo-Chinese, Ethiopian and a few of the New World, is represented in these estuarine islands, not found elsewhere execpt in a small part of Mahanadi and Godavari deltas and the Bay islands. Prain (1903) listed 334 species of plants in the Sundarban, and stated that the different possible means of dispersal and distribution of plants such as by sea and rivers, and by wind, bird and human agencies, have been responsible for introducing an interesting and complex flora in the area.

Champion (1936) classified the Sundarban forests as moist tropical seral forest type (primary seral type), which he described as (*a*) 1S/1 beach forest and (*b*) 1S/2 tidal forests. The tidal forests are subdivided into four sub-types, namely, 1S/2 (a) low mangrove forests, 1S/2 (b) tree mangrove forests, 1S/2 (c) salt-water *Heritiera* forests and 1S/2 (d) freshwater *Heritiera* forests. Except the low mangrove and the salt-water *Heritiera* forests the other types of tidal forests do not occur in the Sundarban that lies within the Indian territory.

Sea-face (beach) flora.

The beach forest occurs on the sea-face islands. Sea-sand blown by strong winds form low sand-dunes. The sands, together with lime formed from disintegrating shells and salt, give rise to a pronounced xerophytic habitat, inspite of the facts that the rainfall in this area is over 125 cm (50 inches) and the subsoil water is just below half a metre or so. These conditions are very different from those prevailing in swamp islands, and thus provide a foothold for the littoral south-east Asian species. The islands are subject to strong north-western storms from

March till May and to cyclones which develop from Bay of Bengal in May and October-November. These cyclones cause considerable damage to the biota of the islands. The trees get uprooted and those that stand the rigours are stunted and deformed, devoid of branches and are more or less leafless. Savannah flourishes under such conditions. The sand-dunes are partially covered with tall brown spear-grass and a fence of shrubs and creepers immediately follows the sand-dunes.

A list of the more important species of plants occurring under such conditions are given below.

Species	Local name	Type of plant	Remark
Family TAMARICACEAE			
Tamarix troupii	Jhao	Shrub or tree	Grows up to 7 metres
Family LEGUMINOSAE			
Erythrina variegata	Palita Mandar	Prickly tree	
Canavalia maritima		Sand-binder, climber	
Canavalia gladiata		Extensive sand-binder, climber	
Derris scandens	Nonalata	Large climber	
Derris sinuata	Sundrilata	Climber	
Caesalpinia bonducella	Nata	Large thorny climber	
Family FICOIDAE			
Sesuvium portulacastrum	Noona	Extensive climber	Excellent sand-binder
Family COMPOSITAE			
Wedelia scandens	Keshraj	Climber over bushes	
Launaea sarmentosa		Herb	Sand-binder
Family MYRSINEAE			
Aegiceras corniculatus	Kulsi	Tree	Grows up to 7 metres
Family SALVADORACEAE			
Azima tetracantha	Trikanta gati	Thorny shrub	
Family CONVOLVULACEAE			
Ipomoea pes-caprae	Chhagalburi	Herb	Very common, excellent sand-binder
Family FLAGELLARICEAE			
Flagellaria indica	Kuh-bent	Cane-like climber	
Family CYPERACEAE			
Pycreus polystachyos	Junglimodhi	Sedge	Sand-binder
Fimbristylis spp.	Halaiya	Sedge	Sand-binder
Family GRAMINEAE			
Oryza coarctata	Bani-Dhan	Perennial grass	excellent sand-binder

Phragmites karka	Nal	Tall reed-like grass	Sand-binder
Imperata cylindrica	Ulu	Wiry grass	-Do-
Zoysia martella		Wiry grass	-Do-
Saccharum spontaneum	Khagra	Tall grass	
Family MALVACEAE			
Hibiscus tiliaceus	Bhola	Heavy climber	
Thespesia populnea	Paraspipal	Tree	Grows up to 10 metres
Family POLYPODIACEAE			
Acrostichum aureum	Udobon	Fern	Bushy plant

Formative (new) Island or Bank Flora

The formation of a new bank is the outcome of natural process of erosion of the banks on one hand by sets of river current and on the other hand by the compensating acceleration of shelving alluvium on the opposite side. The formation of a new island has already been discussed under topography. On these banks and islands "chars", *Oryza coarctata* "Bani-Dhan" appears along with *Sesuvium portulacastrum* "Noona". These are sometimes associated with *Myriostachya wightiana* at the river edge when such an edge drops suddenly into deep water. In the second line of succession a belt of undershrub bushes of *Acanthus ilicifolius* "Hargoza" and young *Avicennia officinalis* "Baen" appears. After these get established, *Excoecaria agallocha* "Gengwa", and *Rhizophora* sp. "Goran", *Sonneratia* sp. "Keora", etc., are the last to establish themselves under protection of "Hargoza" and "Baen". When all these shrubs and trees have properly established themselves, the grass disappears.

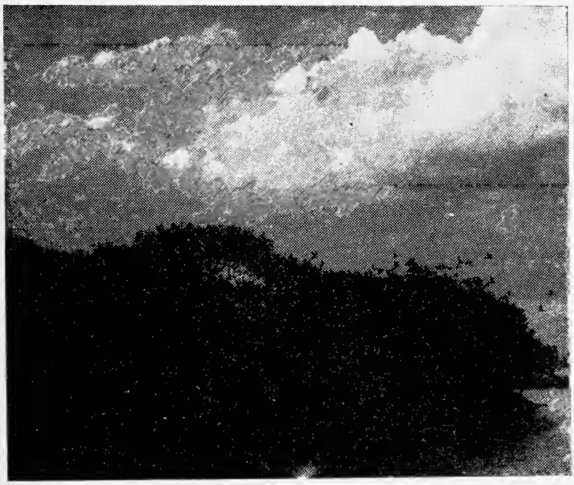
Forest flora

Salt-water *Heritiera* Forest

Salt-water *Heritiera* forest is a low salinity forest that exists along the south-eastern border of West Bengal along Khulna District (Bangladesh). Since freshwater of the Ichhamati River flows into the Raimangal river, the rivers between the Raimangal and Matla have reduced salinity. This has helped in the growth of a fairly dense forest consisting of numerous species tolerant of such water. The average height of the forest trees is from 6 to 11 metres, but some trees like *Sonnerita* sp. "Keora" may attain a height of 20 metres or so. The girth of the trunk is moderate. In the sheltered bays and creeks mangrove occurs. The mangrove are largely *Rhizophora* "Garjan", *Bruguiera* "Kankra", *Ceriops* "Goran" and *Avicennia* "Baen". Typical pneumatophores, that is, respiratory roots of *Avicennia* that project above soil, locally known as "shulas", occur everywhere. The stilt roots of *Rhizophora* and *Bruguiera* are meant for support and are special adaptive features.

1

2



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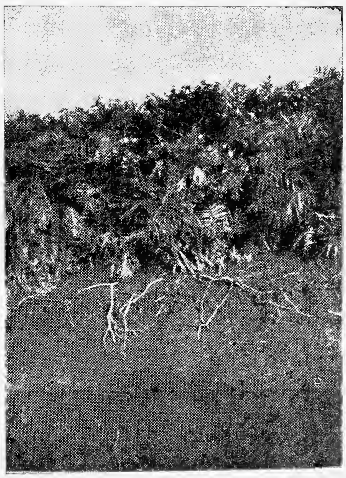

4

1. Fairly dense tall-tree forest; 2. A tidal creek flowing through dense low forest; 3. Morning exercise of water-birds at Sajnakhali forest; 4. Clusters of wild date-palm, a very common plant.

Heritiera "Sundri" which is found scattered over areas of a slightly higher level does not seem to have natural satisfactory regeneration. Along with *Heritiera, Sonneratia, Excoecaria, Carapa* spp., from the upper storey. The palms, *Phoenix paludosa* "Hental" which commonly grows gregariously everywhere on higher elevations, and *Nipa fruticans* "Golpata" though present infrequently are met with on wet mud-banks along the creeks. Mangrove like *Rhizophora* and *Bruguiera* exhibit 'vivipary' (young plants germinate in the fruit while attached to the mother plant). It remains viable until the seed is able to find soil after it drops in water, which may take considerable time.

Low Mangrove Forest

The low mangrove forest which lies between Matla and Muriganga is absolutely devoid of fresh-water, since the rivers in this area are cut off from the ramifications of the Hooghly in the north.

The whole forest area is on soft tidal mud which gets submerged by salt-water at every tide. A dense forest of very low average height (3 to 6 metres) covers the area. Here the vegetation is identical to that of the preceding type, except that *Sundri* and *Golpata* are practically absent. The trees are evergreen and cluster gregariously, the leaves are leathery and the seeds are viviparous. The most common trees are *Ceriops* sp. "Goran" and *Avicennia* "Baen" which occupy extensive areas but grow only up to two metres. The clusters of *Phoenix* sp. "Hental" are extremely common.

A list of some important trees, shrubs and grass which compose the flora of this type of forest is given below:

Species	Local name	Type of plant
Family MELIACEAE		
Amoora cucullata	Amur	Tree
Xylocarpus moluccensis	Passur	Tree
Carapa obovata	Dhundul	Tree
Family LEGUMINOSAE		
Afzelia bigugata	Bhaila	Tree
Cynometra ramiflora	Singra	Tree
Family RHIZOPHORACEAE		
Rhizophora candelaria	Goran	Tree
Rhizophora conjugata	Goran	Tree
Rhizophora apiculata	Goran	Tree
Ceriops tagal	Goran	Tree
Ceriops roxburghiana	Goran	Tree
Bruguiera gymnorhiza	Kankra	Tree
Family LYTHRACEAE		
Sonneratia apetala	Keora	Tree
Family VEBENACEAE		
Avicennia officinalis	Baen	Tree
Avicennia alba	Baen	Tree

Family EUPHORBIACEAE		
Excoecaria agallocha	Gengwa	Tree
Family PALMAE		
Phoenix paludosa	Hental	Palm

Flora of the Reclaimed Area

The reclaimed cultivated tracts are low lying islands which some two hundred years ago were covered with dense forest. Gradual deforestation, cordoning of the islands with high embankments, and repeated monsoon washing of the salinity of the soil made the area cultivable. Many tanks were dug out filling up with rain-water to meet man's requirement of freshwater from the beginning of the human settlement in these reclaimed islands. Various trees and other plants were also introduced. Thus, a complex flora of the original Sundarban species together with some plants from other parts of India and even from abroad are found there today. A list of the more familiar introduced plants are given below:

Species	Local name	Type of plant
Family RHAMNACEAE		
Zizyphus mauritiana	Kul	Small tree
Family LEGUMINOSAE		
Cyamopsis tetragonolobus	Guar	Annual crop (60-100 cm)
Sesbania grandiflora	Bokphul	Soft-wood tree
Tamarindus indica	Tentul	Large tree
Parkinsonia aculeata	Belati kikar	Hedge
Acacia nilotica	Babul	Shrub or tree
Family MELIACEAE		
Azadirachta indica	Neem	Large tree
Family MYRTACEAE		
Psidium guajava	Payara	Small tree
Family AMARANTHACEAE		
Amaranthus polygamus	Champanote	Pot herb
Family PALMAE		
Areca catechu	Supari	Palm
Cocos nucifera	Narikel	Large palm
Family GRAMINAE		
Oryza sativa	Dhan	Cultivated crop

Some important common herbs, shrubs, and grasses that are met with in the rice fields and around the villages are listed below:

Species	Local name	Type of plant
Family LEGUMINOSAE		
Phaseolus adenanthus	Ban barbati	Climber
Derris sineata	Natua	Prickly shrub

Family CUCURBITACEAE		
Coccinia cordifolia	Ban chinhinga	Climber
Trichosanthes cucumerina	Ban chinhinga	Climber
Family RUBIACEAE		
Ixora coccinea	Rangan	Shrub
Family COMPOSITAE		
Spaeranthus africanus	Kantapalang	Climber
Family ASCLEPIADACEAE		
Sarcolobus globosus	Baolilata	Large climber
Family AMARANTHACEAE		
Psilotrichum ferrugineum	Rakto-siranchi	
Family LILIACEAE		
Asphodelus tenuifolius		
Family TYPHACEAE		
Typha angustata	Hogla	Tall reed
Family GRAMINAE		
Paspalum scrobiculatum	Kodo Dhan	Tall tufted grass
Panicum sp.	Bharanda	Coarse grass
Andropogon aciculatus	Chorkanta	Tufted coarse grass
Phragmites karka	Nal	Reed
Arundo donax	Sukna	Reed like grass

Besides the flora of the northern plains a number of littoral species occur in the reclaimed area along embankments and edges of creeks. Such species are:

Species	Local name	Type of plant
Family LEGUMINOSAE		
Canavalia gladiata	—	Extensive climber
Vigna luteola	—	Climber
Derris trifoliata	Panlata	Shrub
Pongamia pinnata	Koronja	Tree
Caesalpinia crista	Singrilata	Shrub
Family COMPOSITAE		
Wedelia sp.	Bhimarj	Creeper
Family MYRSINEAE		
Aegiceras corniculatum	Khalsi	Tree
Family VERBENACEAE		
Avicennia officinalis	Baen	Tree
Family LYTHRACEAE		
Sonneratia apetala	Keora	Tree
Family RUBIACEAE		
Morinda bracteata	Barachand	Tree
Family PLUBAGINEAE		
Aegialitis rotundifolia	Satari	Tree
Family EUPHORBIACEAE		
Excoecaria agallocha	Gengwa	Tree

Family ACANTHACEAE		
Acanthus ilicifolius	Nonajhar	Shrub
Family CYPERACEAE		
Cyperus articulatum	—	Grass
Family PALMAE		
Phoenix paludosa	Hental	Palm

Fauna

Forest Fauna

The extensive saline swamp-forests of the Sundarban spread over the greater part of the sea-face of West Bengal, are inhospitable for animals due to lack of sweet water. In these marshy tropical jungles which flourish on the islands that are washed by the tidal waters of sea, the animals that have adapted themselves by adjusting their habits are very few. Of them, special mention may be made of the Tiger, *Panthera tigris* (Linnaeus), which is dreaded, since all without exception, are said to be maneaters: the Estuarine Crocodile, *Crocodylus porosus* (Schneider), lies in wait for its prey on shores and creeks on soft mud of the tidal flats between bayonet-like stilt and knee roots, where walking is difficult and man sometimes becomes its victims; and the large poisonous snake, the King Cobra, *Ophiophagus hannah* (Cantor).

A hundred years ago the Sundarban forests were the home of many wild animals, some of which like the Javan Rhinoceros, *Rhinoceros sondiacus* Desmarest, and the Wild Buffalo, *Bubalus bubalis* (Linnaeus) are no longer there. The last record of the Rhinoceros from this area is based on the specimen collected in 1870 and preserved in the collection of the Zoological Survey of India, Indian Museum, Calcutta and the Wild Buffalo was known to have existed up to 1885. It is said that the Swamp Deer, *Cervus duvauceli* Cuvier, Muntjac, *Muntiacus muntjak* Zimmermann, and the Fishing Cat, *Felis viverrina* Bennet, existed on these swamp-islands, but these have not been recorded in recent years from the Sundarban forests that lie in West Bengal.

An exhaustive faunistic report is not within the scope of the present paper. However, commoner animals encountered by me in the course of visits during 1955-1960 to the area and those found by others are mentioned below.

VERTEBRATES

Mammals:

The order primates is represented by a single species, the Rhesus Monkey, *Macaca mulatta* (Zimmermann). Mukherjee & Gupta (1965) have studied the peculiar habits of this monkey and its specialised

adaptation to the estuarine island life, where freshwater is not available at all except rain-water, rendering such areas normally unsuitable for primate life. The other mammals are the Tiger, *Panthera tigris* (Linnaeus) which leads an almost amphibious life in swamps, moving from one island to another by swimming through the large rivers and creeks, and during tidal bores it clings to low mangrove branches or is driven to elevated parts of some islands restricting its movement till normal conditions are restored. Its man-hunting is perhaps due to its inability to obtain sufficient food under such adverse conditions, as it is unable to kill the deer or pig that are found on these islands.

In the tidal rivers, the commonest aquatic mammal is the Little Porpoise or the Black Finless Porpoise, *Neomeris phocaenoides* (Cuvier). The other Cetacea that frequent the tidal waters are *Orcella brevirostris* (Owen) and *Stolia plumba* Cuvier.

B i r d s

Sundarban forest has a wealth of waterbirds. Birds such as herons, egrets, storks, ibises, cormorants, shags, darters, etc. which nest in colonies find these forest areas safe and convenient for their living and breeding. The discovery of the existence of a natural bird sanctuary, namely, 'Pakhirala' at Sajnakhali in this area has already been reported by Mukherjee (1955).

Resident species:

1. White Ibis *Threskiornis melanocephala* (Latham)
2. Openbill Stork *Anastomus oscitans* (Boddaert)
3. Adjutant Stork *Leptoptilos dubius* (Gmelin)
4. Blacknecked Stork *Xenorhynchus asiaticus* (Latham)
5. Red Junglefowl *Gallus gallus* (Linnaeus)
6. Swamp Partridge or Kyah *Francolinus gularis* (Temminck)
7. Blackcapped Kingfisher *Halcyon pileata* (Boddaert)
8. Whitecollared Kingfisher *Halcyon chloris* (Boddaert)
9. Brownwinged Kingfisher *Pelargopsis amauroptera* (Pearson) (Prefers broad tidal rivers)

Seasonal visitors:

1. Whimbrel *Numenius phaeopus* (Linnaeus)
2. Curlew *Numenius arquata* (Linnaeus) (Occasional)
3. Blacktailed Godwit *Limosa limosa* (Linnaeus)
4. Little Stint *Calidris minutus* (Leisler)
5. Dunlin *Calidris alpinus* (Linnaeus)
6. Eastern Knot *Calidris tenuirostris* (Horsfield)
7. Curlew-sandpiper *Calidris testaceus* (Pallas)
8. Greenshank *Tringa nebularia* (Gunnerus)
9. Terek Sandpiper *Tringa terek* (Latham)
10. Snipebilled Godwit *Limnodromus semipalmatus* (Blyth)

Rare visitors:

1. Giant Heron *Ardea goliath* Cretzschmar
2. Spottedbilled Pelican *Pelecanus philippensis* Gmelin
3. Herring Gull *Larus argentatus* Pontoppidan
4. Lesser Crested Tern *Sterna bengalensis* Lesson

5. Large Crested Tern *Sterna bergii* Lichtenstein
6. Sooty Tern *Sterna fuscata* Linnaeus

There are several species of smaller perching birds that frequent the forests such as flycatchers, warblers, pipits, wagtails. Blyth's Mangrove Whistler, *Pachycephala grisola* Blyth is sometimes observed among the wild date palm clusters.

Reptilia

The reptilian fauna is represented by snakes, lizards, and crocodile. No chelonians are known from the area.

1. Keelback *Amphiesma stolata* (Linnaeus)

Common species:

2. Hurriah *Enhydris enhydris* (Schneider)
3. *Hydrophis obscurus* (Daudin)
4. *Gerardia prevostiana* (Eydoux & Gervais)
5. Wart Snake *Acrochordus granulatus* (Schneider)

Uncommon estuarine species:

1. *Hydrophis nigrocinctus* (Daudin)
2. *Hydrophis caerulescens* (Shaw)
3. *Microcephalophis cantoris* (Gunther)

Terrestrial snakes:

1. Cobra *Naja naja* (Linnaeus)
2. King Cobra *Ophiophagus hannah* (Cantor)
3. Whip Snake *Ahaetulla nasutus* (Lacepede)
4. Indian Python *Python molurus* (Linnaeus)

Lizards:

1. Water monitor *Varanus salvator* (Laurenti)
2. Monitor Lizard *Varanus flavescens* (Gray)

There is a single species of crocodile, the Estuarine Crocodile *Crocodylus porosus* (Schneider), which inhabits the lower reaches of the tidal rivers.

Amphibia

Amphibians on these islands are very few. The toad, *Bufo melanostictus* Schneider, is sometimes seen in certain elevated parts. The tree frog, *Rhacophorus maculatus* (Gray), is quite common.

Fishes

The fishes are brackish water and marine forms, freshwater ones being totally absent.

The tidal rivers and creeks which flow through forest blocks and the estuaries that surround the forested islands on the sea-face contain varied species of sharks and brackish water fishes. The species of sharks that are commonly met with belong to the genera, *Chiloscyllium, Stegostoma, Scoliodon, Carcharhinus, Rhinobatus* and *Dasyatis.*

There are several species of Teleostomi of which a few important and common species that are commercially exploited are:

Hilsa ilisha (Hamilton)
Ilisha filigera (Valenciennes)
Raconda russelliana Gray
Nematalosa nasus (Bloch)
Anguilla bicolor McClelland
Muraena tile (Hamilton)
Muraenesox cinereus (Forskal)
Pisoodonophis boro (Hamilton)

Anodontostoma chacunda (Hamilton)
Setipinna taty (Valenciennes)
Harpodon nehereus (Hamilton) 'Nehere'
Tachysurus jella (Day)
Tachysurus caelatus (Valenciennes)
Tachysurus gagora (Hamilton)
Tachysurus maculatus (Thunberg)
Tachysurus sagor (Hamilton)
Tachysurus sona (Hamilton)
Mystus gulio (Hamilton) 'Gule'
Anguilla bengalensis (Gray)
Xenentodon cancila (Hamilton)
Strongylura strongylura (van Hasselt)
Aplocheilus panchax (Hamilton)
Oryzias melastigmus (McClelland)
Mugil parsia Hamilton
Mugil tade Forskal
Polynemus heptadactylus Cuvier
Polynemus paradiseus Linnaeus
Eleutheronema tetradactylus (Bloch) 'Gurjaoli'
Lates calcarifer (Bloch) 'Bhetki'

The sea-fishes that enter the backwaters are:

Scatophagus argus (Linnaeus) 'Butterfish'
Stromateus cinereus (Bloch) White Pomfret
Parastromateus niger (Bloch) Black Pomfret
Pampus chinensis (Euphrasen)
Datnioides quadrifasciatus (Sevastianov)
Leiognathus blochii (Valenciennes)
Pama pama (Hamilton)
Otolithes maculatus Cuvier
Sparus datnia (Hamilton)
Toxotes chatareus (Hamilton)
Brachirus pan (Hamilton)
Cynoglossus bilineatus (Lacepede)
Cynoglossus lingua Hamilton 'Tongue Sole'
Mastacembelus armatus (Lacepede)
Mastacembelus pancalus (Hamilton)
Macrognathus aculeatum (Bloch)

The goggle-eyed Gobiids attract the attention of every person due to their active, frog-like hopping on exposed mud-flats, specially during ebb-tide. Generally two species occur, *Periopthalmus keelreuteri* (Pallas) and *Boleopthalmus boddaerti* (Pallas) and several other species. They are not of commercial importance.

Invertebrates:

The invertebrates that are found in the forest area are more or less are represented in the reclaimed area also, except some crop-pests and freshwater animals, and have been listed under that chapter (pp. 17-19). Oligochaeta have been, scanty, whereas several species of Polychaetes are found burrowing in the mud, such as, *Ficomatus macrodon* Southern, *Mercierella enigmatica* Fauvel, *Dendronerius estuarina* Fauvel, *Pomatoceros caeruleus* Schmard). The Gastropods that are found on the mud banks and in the wet places in the interior of the forests are *Nerita* sp., *Telescopium* sp., *Melongena* sp., *Ceratoda* sp., *Onchidium* sp. The Bivalva is represented by *Arca* sp., and several species of *Teredo* which are borers of mangrove tree-trunks that get submerged in tidal water. Arthropods are well represented on land and water. An interesting example is the 'Living Fossil', the King Crab, *Carcinoscorpius rotundicauda* (Latreille), which is not uncommon in the shallow waters of the sea-facing islands, sometimes it crawls ashore. The low-forest trees are often found to bear combs of the Rock-Bee (*Apis*

dorsata). The combs sometimes grow so large that they are hardly a few feet above the ground. Insects affecting forest timbers are many. Mention may be made of the Cerambycids, borer-beetles, that cause alarming damage to Goran, Keora, Garjan, Dhudul etc. With nightfall the dark forests of Sundarban glitter with fireflies (*Pteroptyx* sp.) and the water of the rivers and channels also pulsates with luminiscent life, in the plankton.

Fauna of the reclaimed area

The reclamation of the land which rose from mud and clay by deforestation and human settlement has upset the ecology, resulting in the disappearance of major part of the wildlife. What exists today in these cultivated tracts are some common forms of birds and aquatic fauna of the tidal creeks, common to both the reclaimed and the forested areas. From the northern part of the district some animals have immigrated and have established themselves in the reclaimed area, for example, the jackal, fox, civet cats, mongoose and rats. Freshwater fishes have been introduced in the freshwater (sweet-water) tanks, and various insect pests have appeared on cultivated crops which were not known when these areas were covered with virgin forests.

The fauna is represented by practically every group of animal though the higher vertebrates, specially the mammals, are poorly represented.

VERTEBRATES

Mammalia

The mammals in the reclaimed area are few.

Suncus murinus (Linnaeus) House Shrew
Felis chaus (Guldenstaedt) Jungle Cat
Felis bengalensis (Kerr) Leopard Cat
Canis aureus (Linnaeus) Jackal
Vulpes bengalensis (Shaw) Indian Fox
Viverricula indica (Desmarest) Indian Civet
Herpestes edwardsi (Geoffroy) Common Gray Mongoose
Funambulus pennanti (Wroughton) Five-striped Squirrel
Mus booduga (Gray) Field Mouse
Mus musculus (Linnaeus) House Mouse
Bandicota indica (Bechstein) Bandicoot Rat
Rattus rattus (Linnaeus) Common Rat
Cynopterus sphinx (Vahl) Short-nosed Fruit Bat
Taphozous longimanus (Hardwicke)
Megaderma lyra (Geoffroy) Indian False Vampire
Rhinopoma hardwickii (Gray) Lesser Rat-tailed Bat
Hipposideros bicolor (Temminck) Bicoloured Leafnosed Bat
Pipistrellus mimus (Wroughton) Pigmy Pipistrelle
Scotophilus temmincki (Horsfield) Lesser Yellow Bat

Birds

Marsh birds

Bubulcus ibis (Linnaeus) Cattle Egret
Egretta intermedia (Wagler) Smaller Egret
Egretta garzetta (Linnaeus) Little Egret
Egretta alba (Linnaeus) Large Egret
Ardea purpurea (Linnaeus) Purple Heron
Ardea cinerea (Linnaeus) Grey Heron
Butorides striatus (Linnaeus) Little Green Bittern
Nycticorax nycticorax (Linnaeus) Night Heron
Ardeola grayii (Sykes) Pond Heron
Metopidius indicus (Latham) Bronzewinged Jacana

Freshwater Marshes

Gallinula chloropus (Linnaeus) Moorhen
Hydrophasianus chirurgus (Scopoli) Pheasant-tailed Jacana
Rostratula benghalensis (Linnaeus) Painted Snipe
Charadrius dubius (Scopoli) Little Ringed Plover

Open Water

Podiceps ruficollis (Pallas) Dabchick
Nettapus coromandelianus (Gmelin) Cotton Teal
Dendrocygna javanica (Horsfield) Lesser Whistling Teal
Anas crecca (Linnaeus) Common Teal
Tadorna ferruginea (Pallas) Brahminy Duck
Anas acuta (Linnaeus) Pintail
Aythya nyroca (Guldenstadt) White-eyed Pochard
Netta rufina (Pallas) Redcrested Pochard

Sandbanks

Tringa hypoleucos (Linnaeus) Common Sandpiper
Tringa glareola (Linnaeus) Wood Sandpiper
Calidris minutus (Leisler) Little Stint
Capella gallinago (Linnaeus) Fantail Snipe
Numenius phaeopus (Linnaeus) Whimbrel

In the vast cultivated tracts, the Openbilled Storks, *Anastomus oscitans* (Boddaert) feed on snails from paddy-fields, and are seen with the Redwattled Lapwing, *Vanellus indicus* (Boddaert).

The birds of prey found in the area are:

Spilornis cheela (Latham) Crested Serpent Eagle
Haliaeetus leucoryphus (Pallas) Pallas's Fishing Eagle
Haliaeetus leucogaster (Gmelin) Whitebellied Sea Eagle
Haliastur indus (Boddaert) Brahminy Kite
Milvus migrans (Boddaert) Pariah Kite
Accipiter badius (Gmelin) Shikra
Accipiter trivirgatus (Temminck) Crested Goshawk
Icthyophaga ichthyaetus (Horsfield) Greyheaded Fishing Eagle
Pandion haliaetus (Linnaeus) Osprey
Circus aeruginosus (Linnaeus) Marsh Harrier
Falco peregrinus (Tunstall) Peregrine Falcon
Falco severus (Horsfield) Oriental Hobby
Falco tinnunculus (Linnaeus) Kestrel
Gyps bengalensis (Gmelin) White-backed Vulture
Tyto alba (Scopoli) Barn Owl
Otus scops (Linnaeus) Scops Owl
Athene brama (Temminck) Spotted Owlet
Bubo zeylonensis (Gmelin) Brown Fish Owl
Bubo bubo (Linnaeus) Great Horned Owl

A few species of terns, and kingfishers are seen on the larger rivers and in flooded areas. These are:

Gelochlidon nilotica (Gmelin) Gull-billed Tern
Sterna bergii (Lichtenstein) Large Crested Tern
Sterna bengalensis (Lesson) Indian Lesser Crested Tern
Rynchops albicollis (Swainson) Indian Skimmer
Larus brunnicephalus (Jerdon) Brown headed Gull
Larus ridibundus (Linnaeus) Black-headed Gull
Chlidonias hybrida (Pallas) Whiskered Tern
Hydroprogne caspia (Pallas) Caspian Tern
Sterna aurantia (J. E. Gray) Indian River Tern
Sterna hirundo (Linnaeus) Common Tern
Sterna albifrons (Pallas) Little Tern
Sterna fuscata (Linnaeus) Sooty Tern
Ceryl rudis Lesser Pied Kingfisher
Halcyon smyrnensis (Linnaeus) White-breasted Kingfisher
Alcedo atthis (Linnaeus)
Halcyon chloris (Boddaert) White-collared Kingfisher
Halcyon pileata (Boddaert) Black-capped Kingfisher

Besides, there are many species of doves, cuckoos, parakeets, rollers, barbets, woodpeckers, larks, swallows, drongos, crows, tree pie, shrikes, bulbuls, babblers, flycatchers, warblers, thrushes, pipits, sunbirds, flowerpeckers, and finches and other birds, which are not specifically mentioned, for Law (1954, 1956) has already published observational reports about the ornithology of the Sundarban.

Reptilia:

The reptiles in the reclaimed area are represented by snakes and lizards.

The snakes comprise both terrestrial and aquatic forms. The terrestrial snakes are met with in fields and cultivation.

Ptyas mucosus (Linnaeus) Rat Snake
Vipera russelli (Shaw) Russell's Viper
Naja naja kaouthia (Lesson) Indian Cobra
Oligodon arnensis (Shaw) Kukri Snake
Lycodon aulicus (Linnaeus) Wolf Snake
Eryx conicus (Schneider) Russell's Sand Boa
Xenochrophis piscator (Schneider) Common Checkered Keelback
Amphiesma stolata (Linnaeus) Striped Keelback
Enhydris enhydris (Schneider) Hurriah
Hydrophis obscurus (Daudin)
Gerardia prevostiana (Eydoux & Gervais)
Acrochordus granulatus (Schneider) Wart Snake

In the saline waters of rivers and creeks turtles and terrapins are sometimes come across:

Lizards:

Varanus flavescens (Gray)
Varanus salvator (Laurenti)
Calotes versicolor (Daudin)
Chamaeleon zeylanicus (Laurenti)

Turtles:

Pelochelys bibroni (Owen) Coast Soft Shell

Morenia ocellata (Dumeril & Bibron) Bengal Eyed Terrapin

Batagur baska (Gray) Batagur

Lepidochelys olivacea (Eschschottz) Ridley Turtle

Geomyda tricarinata (Blyth) Three-keeled Terrapin

In the tidal rivers and creeks no frogs have been seen. In the water-puddles which are formed as a result of rainfall and in perennial sweet-water reservoirs, the amphibians that are met with are:

Rana cyanophlyctis Schneider. 'Chine-beng'

Rana hexadactyla Lesson. 'Pati Beng'

Rana limnocharis Wiegmann. 'Dhani-beng'

Rana tigerina Daudin. 'Sona-beng'

Bufo melanostictus Schneider. 'Kuno-beng'. Very common. Dry land.

Microhyla ornata 'Dumeril & Bibron'. Smallest frog in the area.

The fishes that are found in the sweet-water pools of the reclaimed areas are:

Introduced species

Labeo rohita (Hamilton). Rui

Labeo calbasu (Hamilton). Kalbose

Labeo gonius (Hamilton)

Catla catla (Hamilton). Katla

Cirrhinus mrigala (Hamilton). Mrigal

Puntius sp. 'Punti'

Danio sp.

Chela sp. 'Chela'

Ambassis sp. 'Rangachanda'

Notopterus sp. 'Pholui'

Rita sp. 'Rita'

Mud fishes

Mastacembelus armatus (Lacepede) and *M. pancalus* (Hamilton).

Channa gachua (Hamilton). Pank-achaks

Oryzias melastigmus (McClelland). Techoko.

Cat fishes

Clarias batrachus (Linnaeus) *Heteropneustes fossilis* (Bloch)

The other brackish water fishes which get into creeks of the reclaimed area have been dealt separately under the fauna of the forest area.

INVERTEBRATA

The common invertebrates of the area are represented by the Phyla Mollusca, Arthropoda, and Annelida.

Mollusca:

Freshwater

Viviparus bengalensis (Lamarck)

Melanoides tuberculatus (Muller)

Melanoides scabra (Muller)

Lymnaea acuminata (Lamarck)

Indoplanorbis exustus (Deshayes)

Pila sp. (Widely dispersed by the monsoon waters)

Arthropoda

Crustacea:

Several species of crustaceans abound in freshwater ponds and jheels. The smaller prawns commonly found in freshwater are:

Macrobrachium lamarrei (Milne-Edward). 'Kuncho chingri'

Leander styliferus (Milne-Edward)

Caridina gracilipes de Man. 'Ghunso chingri'

Macrobrachium rude (Heller). 'Goda chingri'

During the monsoon very large number of prawns find their way from the brackish water into the paddy fields. In such flooded fields two species are met with:

Metapenaeus brevicornis Milne-Edward, 'Dhanboni chingri'
Metapenaeus monoceros Fabricius, 'Koraney chingri'

The most common crab in the paddy fields during the monsoon is the small grapsid crab *Varuna litterata* (Fabricius), 'Chiti kankra'. In brackish water the common forms met with are: *Scylla serrata* (Forskal), *Portunus pelagicus* (Linnaeus), *Portunus sanguinolentus* (Herbst). *Matuta victor* Fabricius, which is also found in the tidal rivers but appears to be less common there. The common crab that attracts attention is the orange-coloured Fiddler Crab (*Uca* sp.) which actively moves about on mud-flats during ebb-tide in large numbers. The freshwater crabs are: *Paratelphusa* (*Barytelphusa*) *jacquemontii* (Rathbun), and *Paratelphusa* (*Barytelphusa*) *spinigera* Wood-Mason are found in smaller numbers in freshwater tanks and flooded paddy fields. They appear to have been introduced by human agency. Certain deep burrows in soft mud banks of tidal creeks are the homes of the Ghost Crab, *Thalacina anomala* Herbst, which looks more or less like Lobsters hence it is locally known as 'Patal Chingri'.

Insecta:

The reclaimed areas which now are used for extensive cultivation of paddy have large number of insect pests that were probably not known in these areas a century ago when the islands were covered with forests. They appear to have followed paddy cultivation. Besides, there are several insects of minor significance, terrestrial as well as aquatic. It is not worthwhile to furnish a list of all insects that occur there but some more important pests of agricultural crops which were observed during 1955-1965 and some of the commoner aquatic bugs, beetles and dragonflies are mentioned below:

The agricultural pests, mainly of paddy, were found in the sprouting ears of *Aus*, and the nurseries of *Aman* crop.

Rice Thrips *Hispa* (*Dicladispa*) *armigera* Oliver
Paddy Curculionid *Tanymecus indicus* Faust
Some lepidopterus larvae are:
Swarming Caterpillar *Spodoptera mauritia* (Boisduval)
Rice Caseworm *Nymphula depunctalis* Guenee
Paddy Jassid *Nephotettix bipunctatus* Fabricius

During September and October when young plants of *Aman* paddy crop attained a height of 15 to 30 cm, the infection by caterpillars and thrips were appreciably reduced. The additional pests that were noticed then were: Ricehopper *Hieroglyphus banian* Fabricius which cause appreciable damage and Paddy Mealybug *Ripersia oryzae* Green which was found infecting certain plots only, specially those near swamp

areas having reeds and tall grass. By December when the paddy was almost mature some paddy pests other than these mentioned above were found: Surface Grasshopper (*Acrotylus* sp.), Blue Beetle *Haltica cyanea* Weber, flower feeding Blister Beetle *Epicauta* sp. which affected the paddy-ears to a great extent. A large number of bugs invaded standing crop to suck the sap of shoots and ears of paddy. Such bugs were:

Gandhi Bug *Leptocorisa acuta* Thunberg
Caterpillars that were found affecting paddy-shots were:
Paddy Skippers *Pelopidas mathias* (Fabricius)
Paddy Leafroller *Cnaphalocrocis medinalis* Guenee
Striped Bug *Tetroda* sp.
Climbing Cutworm *Cirphis unipuncta* Haworth

In freshwater or slightly brackish water pools and tanks aquatic insects and their larval stages were found in plenty.

Bugs:
Nepid Bug *Laccotrephes robustus* Stal
Ranatra elongata Fabricius
Belostomid Bug *Belostoma indicum* Lep. & Serv.
Enithares indica Fabricius
Plea sp.
Micronecta proba Distant
Micronecta striata Freb.

Water-beetles:
Eretes stictus Linnaeus
Laccophilus flexuosus Aube
Laccophilus parvulus Aube
Canthydrus laetabilis (Walker)
Gyrinids
Dineutes indicus Aube
Hydrophilus olivaceus Fabricius

Dragonflies:
Ischnura sp.
Ceriagrion sp.
Neurothemis sp.
Agriocnemis sp.
Pseudagrion sp.

Damselflies:
Brachythemis sp.
Acisoma sp.
Neurothemis sp.
Pantala sp.
Crocothemis sp.

Arachnida:

The Arachnida are represented by several species of spiders (Aranae). The commoner species that frequent paddy-fields are Argiopids, namely, *Leucage decorata* Blackwell and *Araneus mitifica* (Thorell). These are found on paddy-shoots as well as in bushes near about paddy-fields. Among tall grasses and standing crop a very common species, *Ecuta javanica* Thorell, was met with and also two species of Lycocids, the new web-forming, *Hippasa* sp. whose webs become prominent with dew early in the morning. The common grass spider *Oxopes* sp. is often noticed on ones clothing when one moves through paddy cultivation.

Annelida

Oligochaeta: The commonest species of Oligochaeta that are found in the reclaimed area belong to the genus *Pheretima,* although *Perionyx* and *Eutyphoeus, Dichogaster, Megascolex, Helodrilus, Chaetogaster* also occur. In some of the stagnant pools *Limnodrilus socialis* Stephens was found in great abundance in tangled masses.

Polychaeta: A small polychaete worm, *Mercierella enigmatica* Fauvel which burrows in the mud, was found in great numbers.

Echiurida: In the entertidal mud flats of rivers are found the echiurids which live in 'U'-shaped burrows. The esturine echiurids of Sundarban are represented by three species or perhaps more, the commoner species being *Annalassorhynchus branchirhynchus* (Annandale & Kemp).

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Status of the Nilgiri Langur, *Presbytis johni* in the Anamalai, Cardamom and Nilgiri Hills of the Western Ghats, India[1]

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(*With three maps*)

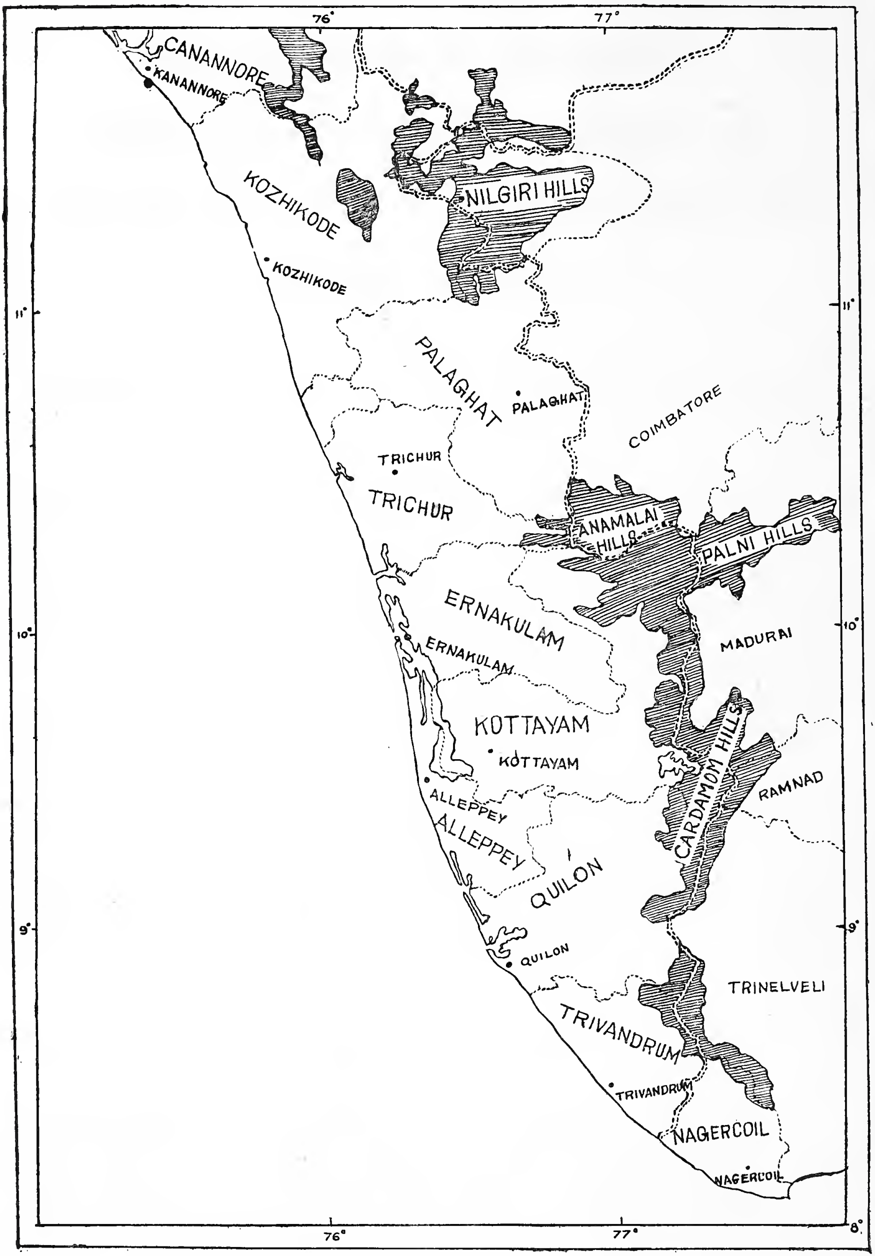
The Southern Regional Station of the Zoological Survey of India has been conducting a faunistic survey of the Western Ghats with special reference to Wildlife. One species of special concern was the Nilgiri Langur, *Presbytis johni,* which on account of a mistaken popular belief in the medicinal or aphrodisiac properties of its flesh, has been persecuted to the verge of extinction. The survey could be carried out only for a month in each year and beginning from the year 1968, representative areas in the Anamalais, Cardamom, and Nilgiri Hills have been visited so far. Anamalais were surveyed during Jan.-Feb. 1968, Cardamom Hills during Feb-March 1969, and Nilgiris during Jan.-Feb. 1971. Results at present are largely impressions and estimates of a subjective nature, which however, are presented here in view of total lack of such surveys and information on this threatened species. A brief account of its present status in each area is given below:

Anamalai ranges

The Anamalai segment of the Western Ghats lies approximately between 10°1′ – 10°30′ N, and 76°30′ – 77°15′ E, covering parts of Coimbatore district of Tamil Nadu and parts of Idikki district of Kerala. The hills are divisible into higher and lower ranges. Average

[1] Accepted May 5, 1973.

elevation of lower ranges is not more than 700 m with peaks and ridges rising to 1300 to 1600 m and mostly covered with luxurient forest. The higher ranges lying to the west consist of extensive open grassy hills



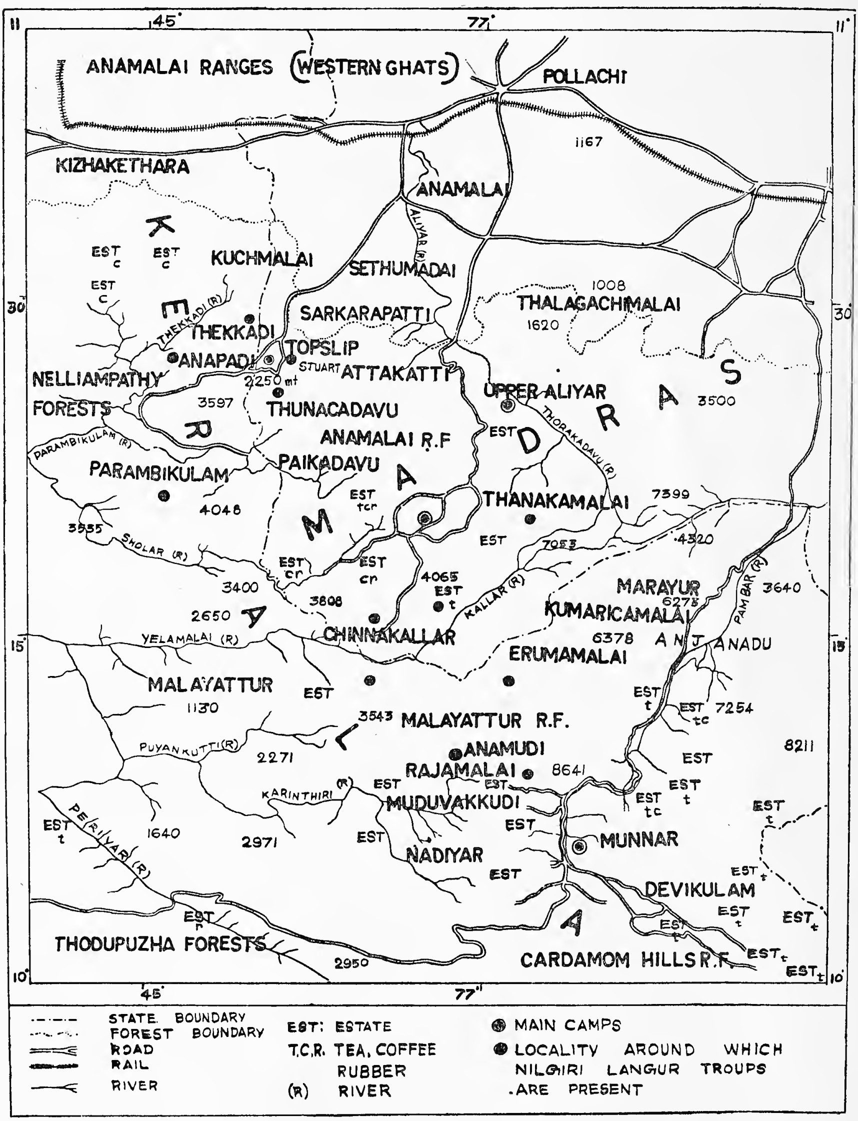
Map 1. Map of Western Ghats showing the three major ranges in which surveys were conducted.

and valleys with shola (slope) forests similar to those of Nilgiris and Palnis and varying from *c* 2000 to 2900 m in elevation. The chief forest types include: (1) Tropical Wet Evergreen forest between 700 to 1600 m in elevation where the trees reach a height of 50 m or more with dense canopy differentiated into layers (2) Tropical Moist Deciduous holding the most remunerative teak forests situated at about 700 to 1300 m in altitude and with a rainfall of 100-250 cm. Trees reach an average height of *c* 35 m (3) Tropical Dry Deciduous forest occurring at the foot of the Hills with open canopy of deciduous trees with considerable undergrowth of grass and (4) Wet Temperate Forest commencing from *c.* 1600 m and mostly confined to summits and consisting of vast stretches of grassland interspersed by compact groves of short and branchy evergreen trees.

Altogether 26 stations were visited for the survey which form a representative sampling of the range of the species. It became fairly certain after the survey that the Nilgiri Langur is at present totally confined to the first two types of forests namely the Tropical Wet Evergreen and Tropical Moist Deciduous which together range in elevation from 700 to 1600 m. Within these two forest types, habitat selection was found to be considerably influenced by presence or absence of human habitation, the langurs having generally withdrawn from their proximity. One exception to this was found at Topslip, a forest official's colony in the Thunacadavu range, where a troop had selected its sleeping quarters in the forest fringe right behind the forest rest house. This is understandable as the animals were assured of protection. Settlements of a largely rural nature like forest villages and tribal hamlets occur within the habitat range. By and large the distribution in the general range was found to be rather patchy, with preferred pockets even in seemingly contiguous, suitable areas. One of the most important influences in the selection of such habitat-pockets was the presence or absence of streams or water courses, the langur establishing itself in the vicinity of such streams. Another factor influencing preference was open or cleared patches within the forests, the troops generally adopting such areas as their sleeping quarters. This is no doubt due to the increased visibility making possible early detection of potential danger.

In the Thunacadavu range of south Coimbatore Division and adjacent forests, troops were seen, heard or reliably reported from areas like Kuchmalai, Thekkadi reserve forest, Anapadi, Sungam, Thunacadavu, Topslip, Thillikal etc, (see map 2). In the Punachi range of the same Division they occur in the forests around lower slopes of Grass Hills, Chinna Kallar, and Kalikundra estate and in the forests to the south-east as far as Munnar in Kerala State. They were also reported to be fairly common in the Eravikulam plateau below Rajamalai area. The Thunacadavu range and adjacent forests of Sungam, Thillikal etc.,

being contiguous and with few villages made a better habitat for the langurs than areas like say Punachi range which was considerably opened up by plantations, settlements and minor towns. A preliminary trial census conducted on transects along water courses and open clearings, the preferred haunts of the langurs gave a tentative estimate



Map 2. Map of South Coimbatore forest division (Tamil Nadu State) including portions of Munnar forest division (Kerala State) in the Anamalai hills, Western Ghats.

of about 80 troops in the Thunacadavu and Punachi ranges (Kurup 1973)[1]. The preferred types of forest habitat may cover approximately 220 sq km in the two ranges.

The species is legally protected in the two ranges of the South Coimbatore Division and also in the Parambikulam area of the Kerala forests. But while this protection has helped a great deal in the recovery of this species in recent years, the ban was not found effective in certain areas. This was so around Valparai in Punachi range and generally in the Parambikulam area of Kerala State. It is considerably more difficult to enforce the ban due to the presence of various estates that dot the hills in the Punachi range. Adequate publicity among the estate staff and other local people, on the need to preserve this beautiful langur and on the fallacy of attributing medicinal value to its flesh may help.

On the whole in the Anamalais the species is picking up in most of the reserve forests. Continuation of the existing ban on its killing and strict vigilance by the forest departments of the two states concerned should see the species firmly re-established in the Anamalais. In this connection the creation by the Tamil Nadu Government of a wild life sanctuary in the Thunacadavu-Punachi ranges of the South Coimbatore Division is a welcome step.

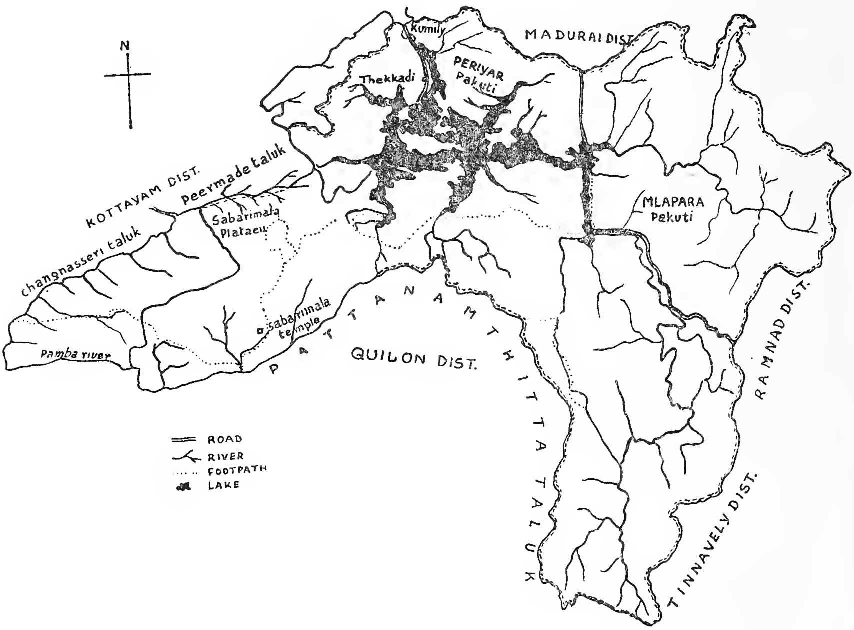
Cardamom Hills

The Cardamom Hills lie immediately to the south of Anamalai Hills, (9°27′–10°4′ N and 76°52′–77°17′ E) with elevations ranging from 650-1300 m and with a total area of 2439.89 sq km. From the Anamalais to the north it is separated by the Devikulam plateau. On the south, the ranges extend as far as the Aryankavu Pass separating it from the southern spurs of the Western Ghats, which taper off near Kanyakumari. Except for the Peermade and Periyar areas for which road connections existed from late last century, the remaining portions, especially the southern half falling in the Quilon district of Kerala State were almost inaccessible and truly wild till recently. With the advent of development in the last decade more and more areas of what was once primeval forests were increasingly encroached upon and thrown open for settlement. The two giant hydroelectric projects, the Sabarigiri Project already completed and the Idikki Project now underway were mainly instrumental in opening up this area.

An area of 777 sq km is constituted as the Periyar Wild life Sanctuary, with the Periyar lake, formed in the wake of the construction of

[1] Kurup, G. U. (1973): Present status of the Nilgiri Langur, *Presbytis johni* in the Anamalais, Western Ghats. *Indian Forester 99*(8):518-521.

Periyar Dam in Periyar river, as the focal point. The sanctuary ranges in elevation from 914 to 1828 m. The meandering lake with its innumerable creeks follows the undulating hills that bear mixed miscellaneous forest interspersed with evergreen forest and grassy summits. Sholas or slope forests here as well as in other parts of Cardamom hills are mostly evergreen whereas the plateau bears deciduous and mixed miscellaneous forests.



Map 3. Map of Periyar Sanctuary, in the Cardamom Hills (Kerala State) of Western Ghats.

Altogether 12 localities (map 3) both within and outside the sanctuary were specially surveyed by transecting likely areas. A number of boat trips were also made to different areas surrounding the lake. In a week's survey of the lake part of the sanctuary only twelve troops were seen, besides three more heard calling. This is in addition to the two troops that are living on either side of the approach road to the boat landing at Thekkadi (the headquarters of the Sanctuary) whose presence had created an initial impression of abundance of these langurs in the sanctuary. This impression was soon proved to be erroneous. Though the Forest Department personnel as well as other local knowledgeable people stated that the langurs are more numerous than the sighting records would suggest, yet they also agreed that they are by no means abundant or quite common in the interior. It was also told that they are present in far better numbers towards the more inaccessible eastern parts of the sanctuary i.e.; in the Malapara Pakuti.

It was believed locally that the majority of the population in the sanctuary lived in areas near the border with Tamil Nadu.

Areas towards the west and south of Thekkadi and those around Peermade and Sabarimala plateau proved to be very disappointing. These are more opened up with plantations and recently laid out roads in the wake of the Sabarigiri Pamba Hydroelectric Project and also due to the tremendous annual Pilgrimage to the forest temple of Sabarimala. Moreover, considerable acrèage (*c* 4922 acres of Eucalyptus alone by Forest Department), has been developed into plantations of rubber and eucalyptus here. Biotope is also rather different here from that of Thekkadi forests due to lesser rainfall. Most of the langurs have consequently fled from these areas with the exception of very interior areas. Not even a single troop was sighted in the forests immediately around Vandiperiyar, Anathod, Pamba and Sabarimala although locally it was told that they are sporadically seen in the interior forests, but in small numbers. Thus the position of the species in these parts of the sanctuary appears to be unsatisfactory.

After a survey lasting a little less than a month, a tentative estimate is that there might be only less than a hundred troops in the sanctuary.

In the areas lying north to the sanctuary towards Panniyar, Kallar, Bodimettu etc., on way to Devikulam they are said to be more numerous but due to lack of time these areas could not be visited. They are also said to hold their own in the forests to the south-west of the sanctuary in portions of Pathanamthitta taluk of Quilon district. In all these areas their favourite haunts are the shola forests.

Nilgiri Hills

The status in the Nilgiri ranges which conferred the common name on these langurs is alarming. These ranges along with the high ranges of Anamalai Hills constitute the most magnificent mountains of the Western Ghats. Many peaks rise to more than 2250 m in elevation, the highest being the Dodabetta peak near Ootacamund with a height of 2634 m, second only to Anaimudi peak in Anamalais, the highest in Peninsular India. On the whole these ranges can be divided into three zones: (1) the lower slopes of the hill ranges up to *c* 1500 m (2) the highland rolling hills and the high table lands above this and (3) the vast plateau country at *c* 1000 m on the north-west side extending to Mysore State. The lower slopes bear mainly tropical wet evergreen and tropical deciduous forest depending on the rainfall, the latter type being more extensive on the eatern face of the ranges. There is also a narrow belt of tropical semi evergreen mostly as an associated strip along with tropical evergreen. The highlands which are now mostly cleared land

are almost extensively developed into plantations. There are only sharply circumscribed patches of forests here which are of the wet temperate type. In the extensive lower plateau country where the famed Mudumalai and Bandipur sanctuaries are situated, the forests are of a typical deciduous type presenting the appearance of a "Savanna" with a sprinkling of well distributed trees.

The Nilgiri langurs are now practically confined to the second zone the patchy forests of the highlands. This naturally bodes ill for their survival and is a cause of concern.

Most of the Nilgiri district was covered by Jeep travelling approximately, 2500 km in the highlands, plateau and low lands of the district. The entire Mudumalai Sanctuary was intensively surveyed. In all this area only six troops were actually sighted four near Paikara, and the other two at Naduvattom. In fact, from all accounts, it appears that the Paikara area including, Mukirti, Glenmorgan and Nilgiri Peak and areas around is the remaining stronghold of these langurs But even here they are no means common. Two or three wayside troops near about Paikara, being often and repeatedly sighted have helped to create a wrong impression of plentiful presence of these langurs in this area. Forest department personnel who are also apparently taken in by this belief readily admitted that they are rather uncommon in the interior forests. But on the whole, the consensus of knowledgeable local opinion was that there is an appreciable population of these langurs in this area still and this is the major habitat containing the lion's share of the population in the whole district.

More intensive surveys conducted during a fortnight in the Mudumalai Sanctuary proved beyond doubt that they are totally absent there and in the adjacent Sigur range, and in fact from the entire plateau country around 1000 m. In the Nilgiri district they are thus confined to areas above 2000 m in elevation like Paikara-Naduvattom area mentioned above forming a narrow strip on the western escarpment of the Nilgiri ranges. It is curious that these langurs which are found around 700 m in Anamalais and 1000 m at Cardamom Hills are totally absent from these elevations at Nilgiris and are confined to the still higher areas above 2000 m.

Of all the three segments of the Western Ghats dealt here, it is at once obvious that the Nilgiri area is the one most depleted in population of the Nilgiri Langur. This is no doubt due to the more "developed" state of this district compared to other hill tracts considered here, with the steady encroachment on the forests by plantations, settlements, development projects and the general urbanisation process. The forest department should take special care to safeguard the remaining population of these langurs in the Paikara-Naduvattom area and its interior forests. There should not be any further expansion of the

Wattle and Eucalyptus plantations in these areas. A concerted publicity drive by the forest department in collaboration with the Nilgiri Game Association appears necessary.

In conclusion it appears that human persecution coupled with habitat destruction by encroachment on the forests are the main reason for the decline of the species in recent times and that wherever they are afforded protection from these two destructive factors, they are recouping themselves without any other help. So it can be safely said that given adequate protection in these respects and supported by effective publicity on the need for its conservation and exposing the myth of its medicinal value, the Nilgiri langur population in all these areas have still the vitality and resilience to recoup itself in a short time.

Note added in proof

During a recent status-cum-habitat survey of the Liontailed Macaque, *Macaca silenus* in the Western Ghats conducted in Oct-Nov. 1974, it was found that the Nilgiri Langur is establishing itself well in most portions of its original habitat where human persecution is not acute. Additional areas in which the species was met with or reported are: *Malabar*: Silent Valley and Mukkali forests in Attapadi, Nilambur forests. *Anamalais*: Varagaliyar and Ulandi sholas near Topslip; Marayoor and Topstation forests near Munnar. *Cardamom Hills*: Kallar Valley in Achankovil range. *Southern Spurs*: Tenmalai forests; Papanasam Upper slopes and Singampatty ranges. Neyyar forests. In some of the sholas in the above areas troops were met with every two km. It now appears that habitat preservation and protection from poaching are all that are necessary for the preservation of the species and that it is unaffected by non-destructive human habitation.

Orchids of Nepal - 9[1]

M. L. Banerji[2] and B. B. Thapa[3]

(*With five text figures*)

The genera that are placed under Ophryoideae are treated in this instalment. The tribes had been divided into two by Schlecter, while Schultes and Pease divide them into seven sub-tribes. The arrangement of the genera is alphabetical.

Artificial key to the genera

A Lip not spurred, concave at base............ *Herminium* (Habenarieae)

AA Lip spurred –

B Stem bearing a single leaf.............. *Hemipilia* (Platanthereae)

BB Stem leafy, atleast at the base –

C Spurs two................................ *Satyrium* (Satyrieae)

CC Spur one –

D Stigmatic surface flat, almost confluent.......... *Platanthera* (Platanthereae)

DD Stigmatic surface not flat, but separated as swellings or stand out as appendages................ *Habenaria* (Habenarieae)

Habenaria Willd.

One of the largest genera of Orchids. Terrestrial plants, usually growing from tubers, rarely from a short rhizome; stem simple and erect; bearing few to many basal and cauline leaves which are thin, usually broad, and sheathing at the base. Inflorescence is terminal, usually fairly long of many small or large flowers, dorsal sepal and petals usually form a hood over the column; lateral sepals usually spreading or reflexed; lip spurred and the blade variously shaped, simple, 3 lobed or 3 partite; column short consisting mainly of anther, usually with a small auricle on either side; pollinia 2, separate, clavate or pyriform, the caudicle enclosed in long or short often prominent tubes and separated more or less widely by the rostellum. Stigmas 2, usually separated, convex or on elongated processes on either side of the base of the column, often joined to the base of the lip and auricles, while in some others flat and joined below the rostellum.

There is considerable variation in the details of the structure of the column, especially as regards the stigmas, and some authors have adopted a division of the genus on the basis of the structure of the stigma. Thus, J. J. Smith (1905) divides *Habenaria* into three genera—*Platan-*

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thera, Peristylus and *Habenaria* proper; Schlecter (1926) recognises only two divisions—*Peristylus* and *Habenaria.* According to Holttum (1953) though such divisions may appear distinct in a limited number of species, they are said not to be sharply separable when all the known species are considered. Summerhayes (1951) split the group into distinct genera. Santapau & Kapadia (1960) regard *Platanthera* and *Peristylus* as genera which are independent from *Habenaria.* In the words of Schultes & Pease (1963) "some prefer as in the case of *Habenaria,* to recognise large and inclusive generic concepts, while others more readily separate sections as good genera. There is here no question of right or wrong, but one of personal evaluation." According to Hawkes (1965), *Gymnadenia* is often included in *Habenaria* Willd., and *Peristylus* is in actuality closer in relationship to *Herminium* R. Br. Quoting Schweinfurth (1959) "for instance *Leucorchis* E. Mey., *Gymnadenia* L. C. Rich., *Coeloglossum* Hart., *Platanthera* L. C. Rich., *Blephariglottis* Raf. and *Perularia* Lindl. should be regarded, we believe, as referable to the exceedingly polymorphic genus *Habenaria* Willd. as also *Pectelis* Raf., *Gymnadeniopsis* Rydb., and doubtless others". We have treated *Platanthera* as distinct from *Habenaria* on grounds of the character of the stigmatic surface.

Plantanthera is a name given to those species which have a flat stigmatic surface, usually continuous but sometimes slightly divided beneath the rostellum, very much like the stigma of most orchids. The other divisions of *Habenaria* all have two separate stigmas, which are convex or more or less elongated often club-shaped. If the stigmas are convex and entirely united to the base of the lip and to the auricles of the column, we have the *Peristylus* condition; if the stigmas are long and cylindric or club-shaped, we have *Habenaria* proper. In *Habenaria* proper, the stigmas are often quite long and prominent, they are usually below and shorter than the tubes containing the caudicles of the pollinia.

ARTIFICIAL KEY TO THE SPECIES OF *Habenaria*[1]

A Lateral sepals spreading, deflexed or reflexed –
  B Lip 3-partite almost to the base into 3 narrow lobes –
    C Sepals with filiform tips, spur equalling the ovary...... *stenopetala*
    CC Sepals obtuse, spur shorter than the ovary.............. *aitchisoni*
  BB Lip 3-lobed and spurred –
    C' Side lobes lacerate to the middle, midlobe linear-–
      D Spur rather longer than the ovary –
        E Petals pubescent, broader than the dorsal sepal.......... .... *arietina*
        EE Petals glabrous, linear, narrower than the dorsal sepal .... *pectinata*

[1] *Habenaria arcuata* Lindl. has been recorded from Phulchowki (Nepal) by Hara (1971).

DD Spur twice as long as the ovary.................... *intermedia*

C'C' Sidelobes fimbriate, hardly longer than the lateral sepals –

D' Spur twice as long as the ovary.................. *conopsea*

D'D' Spur longer than the ovary......................... *dentata*

C'C'C' Sidelobes much longer than the lateral sepals –

D" Spike lax flowered; lip flabelliform, sidelobes entire or toothed .... *plantaginea*

D"D" Spike dense flowered; lip very large, sidelobes hatchet-shaped, crenulate .... *triflora*

C'C'C'C' Sidelobes very narrow, fiiliform, horizontal, spur much shorter than the ovary .... *aristata*

BBB Lip 3 lobed, spur almost absent or saccate; spike densely flowered, flowers small .... *fallax*

BBBB Lip entire –

E Spur shorter than the ovary .... *densa*

EE Spur longer than the ovary, upturned................. *latilabris*

AA Lateral sepals erect or ascending, parallel to the dorsal petal, rarely at length spreading or deflexed –

B' Lip usually 3-fid or 3-partite; flowers usually small –

F Spur longer than the sepals, incurved................ *bicornuta*

FF Spur shorter than the sepals –

G Stem more than 60 cm long, leaves petioled....... *constricta*

GG Stem less than 60 cm long; leaves hardly petioled........... .... *goodyeroides*

B'B' Lip entire –

H Flowers large *c* 1.2 cm across; lip shortly clawed, spur short, conical .... *galeandra*

HH Flowers small *c* 0.8 cm across; lip recurved, terminal half solid and terete, spur inflated......................... *urceolata*

HHH Flowers large *c* 1.25 cm across; lip lanceolate, 3-nerved entire; spur slender, curving and longer than the straight ovary...... .... *stenantha*

Habenaria aitchisoni Reichb. f. in Trans. Linn. Soc. Bot. 3:113, 1886; F. B. I. 6:152, 1890; King & Pantl. 311, t. 408, 1898; Kitamura, 102, 1955.

Flowers greenish, fragrant, *c* 1.2 cm in diam., bracts linear-lanceolate, shorter than the ovary; sepals subequal, oblong-ovate, obtuse, 3-nerved, lateral sepals spreading, dorsal erect, petals as long as the sepals, ovate-lanceolate, 1 nerved. Lip straight, as the sepals, 3-partite above the base, side segments longest, spreading and recurved, mid segment straight, spur shorter than the curved ovary, *c* 6 mm long and curved forwards. Flowering time from July to August. Collected from Bankukhola at 3500 m. Authority Kitamura.

H. arietina Hk. f. in Fl. Brit. Ind. 6: 138, 1890; King & Pantl. 311, t. 407, 1898. *H. pectinata* Lindl. Gen. et Spec. Orch. 341, 1830. [non *H. pectinata* (Sm.) Don]

Flowers white or light greenish, fragrant, *c* 5 cm in diam., sepals gibbously dilated on the outer margin; petals broader than the sepals, pubescent. Lip lobed only for about ¾ of its length, sidelobes pectinate

but with fewer teeth, midlobe shorter than the sidelobes, linear, spur much longer than the ovary, 2.5-3 cm long, tip swollen. Flowering during July and August. Collected from Sheopuri, Bagdoar, Sundarijal-Manichur area. Distributed between 1800-2100 m. This species is very similar to *H. pectinata* (Sm.) Don, in habit and appearance but the pectinate lip is different.

H. aristata Hk. f. in Fl. Brit. Ind. 6: 158, 1890; King & Pantl. 312, t. 409, 1898.
Flowers green, *c* 1.5 cm in diam., sepals subequal, linear, lateral sepals turned upwards and spreading, petals conniving with the dorsal sepal to form a hood, ovate-lanceolate, base oblique. Lip slightly longer than the sepals, hastately tripartite, sidelobes filiform and horizontally spreading, midlobe linear and shorter than the sidelobes, spur much shorter than the ovary, curved. Flowering time during July and August. Collected from Bagdoar at *c* 2290 m.

H. bicornuta Hk. f. in Fl. Brit. Ind. 6: 156, 1890; Hara, 437, 1966. *Peristylus richardianus* Wight, Icon. t. 1097, 1851.
Spike dense flowered, flowers *c* 10-12 mm across, dorsal sepal oblong, faintly 5 nerved, lateral sepals linear, obtuse spreading, petals as long as the lateral sepals, elliptic, 1 nerved. Lip tripartite, segments filiform, side lobes longer than the sepals, recurved, midlobe shorter and straight, spur clavate, incurved. Collected from Phulchowki.

H. conopsea Benth. in Journ. Linn. Soc. 18: 345, 1880; Butcher, A new Ill. Brit. Fl. pt. 2, 740, 1961. *Gymnadenia conopsea* R. Br. in Ait. Hort. Kew, ed. 2, 5: 191, 1813; Kitamura, 102, 1955.
Spike rather long and dense flowered, flowers 10 mm across, fragrant, sepals reddish-lilac, lateral sepals spreading, petals linear-lanceolate, slightly united with the dorsal sepal. Lip red with 3 equal rounded lobes, spur filiform, twice as long as the ovary. Authority Kitamura.

H. constricta Hk. f. in Fl. Brit. Ind. 6: 161, 1890; King & Pantl. 325, t. 429, 1898.
Flowers greenish, white, bracts lanceolate, equal to or longer than the ovary; lateral sepals linear-lanceolate, dorsal sepal lanceolate, petals longer, ovate-oblong, gibbous on the lower side. Lip rather longer than the sepals, 3-fid to the middle, sidelobes slender, longer than the midlobe, sometimes variable in size, spur broadly globular and very short, claw hardly any. Flowering during July and August. Collected from Nagarjung. Distributed at 1500 to 1600 m.

H. densa Wall. ex Lindl. Gen. et Spec. Orch. 326, 1835; F. B. I. 6: 153, 1890; King & Pantl. 319, t. 420, 1898; Kitamura, 103, 1955; Hara 437, 1966.

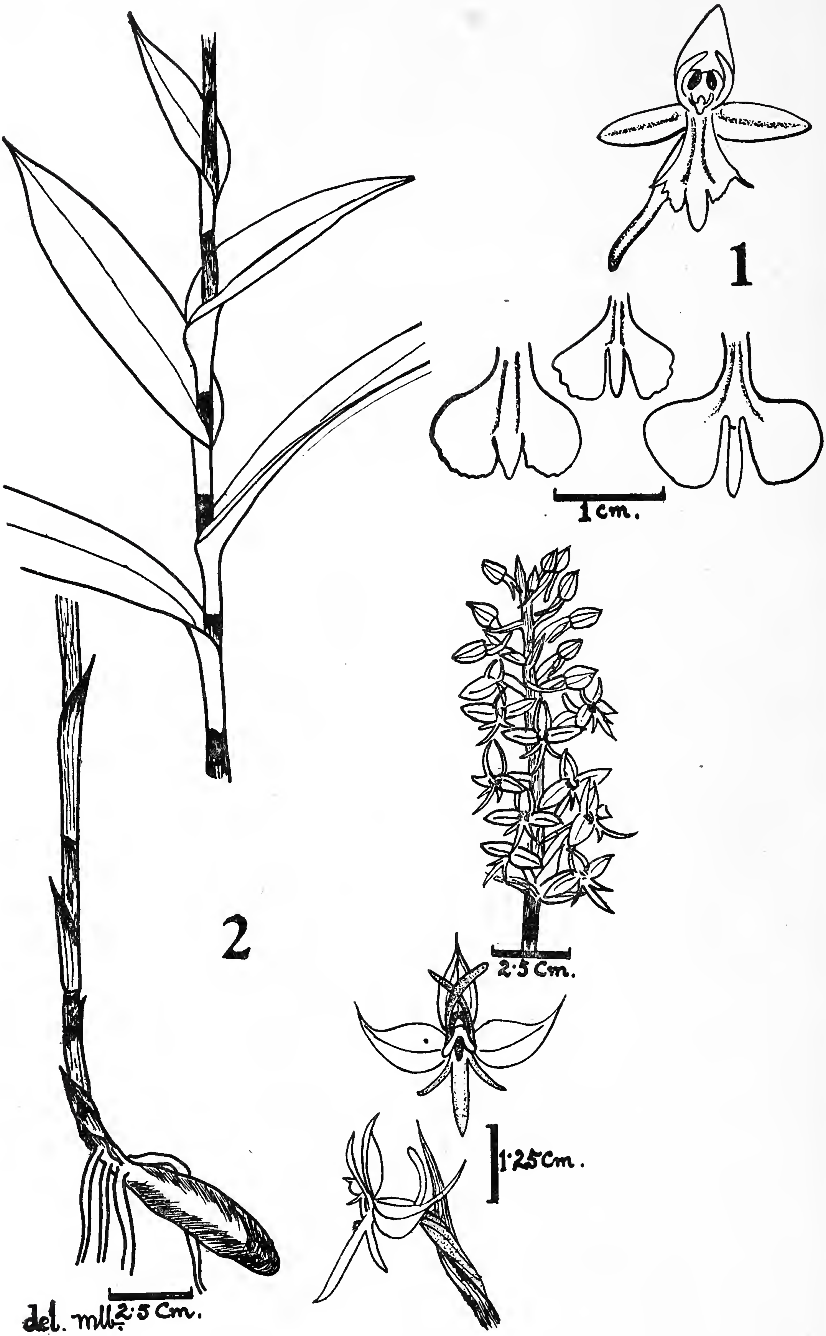

Fig. 1. Flower and lips of *Habenaria dentata* (Sw.) Schltr. Fig. 2. *Habenaria stenopetala* Lindl.

Flowers small, 4 mm across, erect, bracts ciliolate and longer than the ovary; sepals obtuse, thick, 3 nerved, puberulous, petals nearly as long, obliquely ovate or narrower, obtuse, fleshy, yellowish-green. Lip linear, obtuse, as long as the sepals, spur half as long as the ovary. Flowering time July and August. Collected from Chandragiri, Lamjura.

H. dentata (Sw.) Schltr. Orch. Sino-JaP. 125, 1919; Kitamura, 103, 1955; Hara 437, 1966. *Orchis dentata* Swartz. in Ved. Acad. Handl. Stockh. 207, 1800. *Platanthera dentata* (Sw.) Lindl. Gen. et Spec. Orch. 296, 1835. *Habenaria geniculata* D. Don, Prodr. Fl. Nep. 25, 1825; F. B. I. 6: 136, 1890; King & Pantl. 309, t. 405, 1898, (Fig. 1). Spike dense, flowers dull greenish, *c.* 2.5 cm across, lateral sepals acute, petals linear-oblong. Lip suborbicular, sidelobes cuneate or rounded, fimbriate or crenate, midlobe small, much shorter, oblong, spur subclavate, longer than the ovary. Flowering during July and August. Collected from Nagarjung. Distributed at 1525 to 1675 m. In F. B. I. the colour of the flowers is given as white, but we have not seen any specimen with white flowers.

H. fallax (Lindl.) King & Pantl. in Ann. Roy. Bot. Gard. Cal. 8:325, t. 428, 1898; Kitamura, 103, 1955. *Herminium fallax* Lindl. in Wall. Cat. (Nomen nudum); F.B.I. 6:129, 1890. *Peristylus fallax* Lindl. Gen. et Spec. Orch. 298, 1835.
Leaf solitary; spike lax flowered, flowers green, bracts equalling the ovary, sepals spreading, oblong or ovate-lanceolate, 1 nerved, broader than the petals, petals erect, falcate. Lip shorter than the sepals, hastately 3 lobed, side lobes slightly diverging, midlobe longer than the sidelobes, spur saccate, tip inflated. Flowering during July and August. Collected from Sheopuri, Tarebhir, Lamjura. Distributed from 1650 to 2850 m.

H. galeandra (Reichb. f.) Benth. Fl. Hongk. 363, 1861; F.B.I. 6:163, 1890. *Platanthera galendra* Reichb. f. in Linnaea, 25:226, 1852.
Spike 5-8 cm long, flowers pale purple, *c* 1 cm across, dorsal sepal ovate or narrowly lanceolate, lateral sepals falcately lanceolate, spreading, petals rather shorter and narrower than the sepals, obtuse. Lip broadly obovate or obcordate, sidelobes recurved, spur short, conical saccate. Flowering during June to August. Collected from Sheopuri at *c* 1825 m.

H. goodyeroides D. Don, Prodr. Fl. Nep. 25, 1825; F.B.I. 6:161, 1890; King & Pantl. 326, t. 430, 1898; Holttum 86, 1953. *Peristylus goodyeroides* (Don) Lindl. Gen. et Spec. Orch. 299, 1835; Sant. & Kapad. in Journ. Bom. nat. Hist. Soc. 57(1):133, 1960.
Spike 15 to 20 cm long, flowers small, *c* 8-10 mm across, yellowish-green, crowded, bracts narrowly lanceolate, sepals green turning reddish

with age, dorsal sepal 6 mm long, ovate oblong, lateral sepals a bit longer, obliquely obovate-oblong, obtuse, petals gibbously ovate, spreading, creamy or greenish-white. Lip as long as the sepals, trilobed at the anterior part, recurved, sidelobes linear-oblong, longer than the midlobe and diverging, midlobe broad, and tapering to blunt apex, spur minute, fusiform. Flowering during July. Collected from Chainpur to Mialay at *c* 1825 m, locality unrecorded (Banerji).

H. intermedia D. Don, Prodr. Fl. Nep. 24, 1825; F.B.I. 6:38, 1890.
Flowers few and distant, very large *c* 5 cm across, white or greenish-white, dorsal sepal recurved, white inside, lateral sepals falcately lanceolate, tips reflexed, narrower than the petals, acuminate, 5 nerved, petals falcate, obovate, strongly 5 nerved, glabrous. Lip longer than the sepals, 3 lobed to about 2/3rd of its length, green or yellowish-green, base narrow and white, sidelobes deeply fringed, midlobe entire, as long as the sidelobes, spur twice as long as the ovary, *c* 3 cm, very stout and swollen towards the tip. Flowering during August. Collected from Gumuraung to Sarti at 2300 m. Authority Kitamura.

H. latilabris (Lindl.) Hk. f. in Fl. Brit. Ind. 6:153, 1890; King & Pantl. 321, t. 423, 1898; Hara, 438, 1966. *Platanthera latilabris* Lindl. Gen. et Spec. Orch. 289, 1835. *P. acuminata* Lindl. loc. cit. 289, 1835.
Spike lax, flowers green, 8-14 mm across, bracts lanceolate longer than the ovary, sepals ciliolate, 3-5 nerved, dorsal sepal broadest, orbicular, lateral sepals ovate, deflexed, petals as long as the lateral sepals, broadly ovate, fleshy, base slightly gibbous. Lip linear, spur stout and upturned, longer than the ovary. Flowering during August. Collected from Bagdoar.

H. pectinata (Sm.) D. Don, Prodr. Fl. Nep. 24, 1825; F.B.I. 6:137, 1890; King & Pantl. 310, t. 406, 1898. *Orchis pectinata* Smith, Exot. Bot. 2:77, 1805. *Habenaria ensifolia* Lindl. Gen. et Spec. Orch. 321, 1835.
Spike may be as long as 20 cm, flowers large *c.* 4.0 cm across, white or greenish-white, crowded, dorsal sepal lanceolate, erect, lateral sepals ovate-lanceolate, petals linear-falcate, narrower than the sepals, obtuse, 3-5 nerved, glabrous. Lip as long as the sepals, 3 lobed nearly to the base, sidelobes deeply fringed, comb-like, midlobe linear, longer than the sidelobes, spur as long as the ovary, 2.5-3 cm long, geniculate, swollen at the tip. Flowering during August. Collected from Bagdoar, Lokwa (Kitamura). Distributed at about 2300 m.

H. plantaginea Lindl. Gen. et Spec. Orch. 323, 1835; F.B.I. 6:141, 1890.
Spike 5-7.5 cm long, flowers white, sepals small, subequal, acute, 3 nerved, dorsal sepal ovate-oblong, lateral sepals falcate, oblong, petals

linear-lanceolate. Lip broad, twice as long as the lateral sepals, flabelliform, sidelobes semi-ovate entire or faintly toothed, midlobe as long, linear, spur as long as the ovary, green. Flowering during September. Collected from Banepa to Dolaghat at 916 m.

H. stenantha Hk. f. in Fl. Brit. Ind. 6:153, 1890; King & Pantl. 314, t. 412, 1898.
Flowers green with lip yellowish, *c.* 1.75-2.25 cm in diam., bracts linear-lanceolate, equalling the ovary in the lower flowers but shorter in the upper ones, sepals unequal, 3-nerved, dorsal sepal concave, broadly ovate, erect, lateral sepals small, ovate-elliptic, reflexed, petals longer than the dorsal sepal, erect, 1 nerved. Lip longer than the sepals, lanceolate, spur longer than the ovary, curved, slightly widening towards the tip. Flowering time during July and August. Collected from Junbesi to Taksindhu. This species closely resembles *H. latilabris* but differs in the shape of the petals which are erect and in the character of the bracts.

H. stenopetala Lindl. Gen. et Spec. Orch. 219, 1835; F.B.I. 6: 134, 1890; King & Pantl. 308, t. 404, 1898. (Fig. 2).
Flowers greenish-yellow, sepals oblong-lanceolate, membraneous 3 nerved, tips filiform, segments of petals slender, equal or the lower shorter or even absent. Lip tripartite, lobes filiform, lateral lobes longer than the midlobe or as long as it, spur equalling the ovary. Flowering during August and September. Collected from Bagdoar, Sheopuri, Godavari, locality unknown (Herklotts). Distributed at *c.* 2430 m.

H. triflora D. Don, Prodr. Fl. Nep. 25, 1825; F.B.I. 6:142, 1890 (Fig. 3).
Sepals suberect, dorsal sepal oblong-ovate, lateral sepals oblong-lanceolate, petals small, linear-subulate, 1 nerved. Lip very large, sidelobes semi-oblong, hatchet-shaped, crenulate, midlobe shorter, linear; spur very slender, as long as the ovary, slightly thickened at the tip. Flowering from July to early September. Collected from Bagdoar, Lamjura, locality unknown (Herklotts). Distributed at 1525 to 2135 m.

H. urceolata C.B.Cl. in Journ. Linn. Soc. 25:73, t. 30, 1889; F.B.I. 6: 165, 1890; King & Pantl. 316, t. 415, 1898.
Racemes 5-7.5 cm long, flowers white or rosy, sepals white or rosy, petals 1 nerved. Lip recurved, lanceolate, terminal half solid, acuminate, green, spur inflated and as long as the sepals. Flowering during August. Collected from Lamjura at 3650 m.

Hemipilia Lindl.

These are singularly attractive terrestrial orchids. The name probably alludes to the sparsely hirsute lip of the type species. Accord-

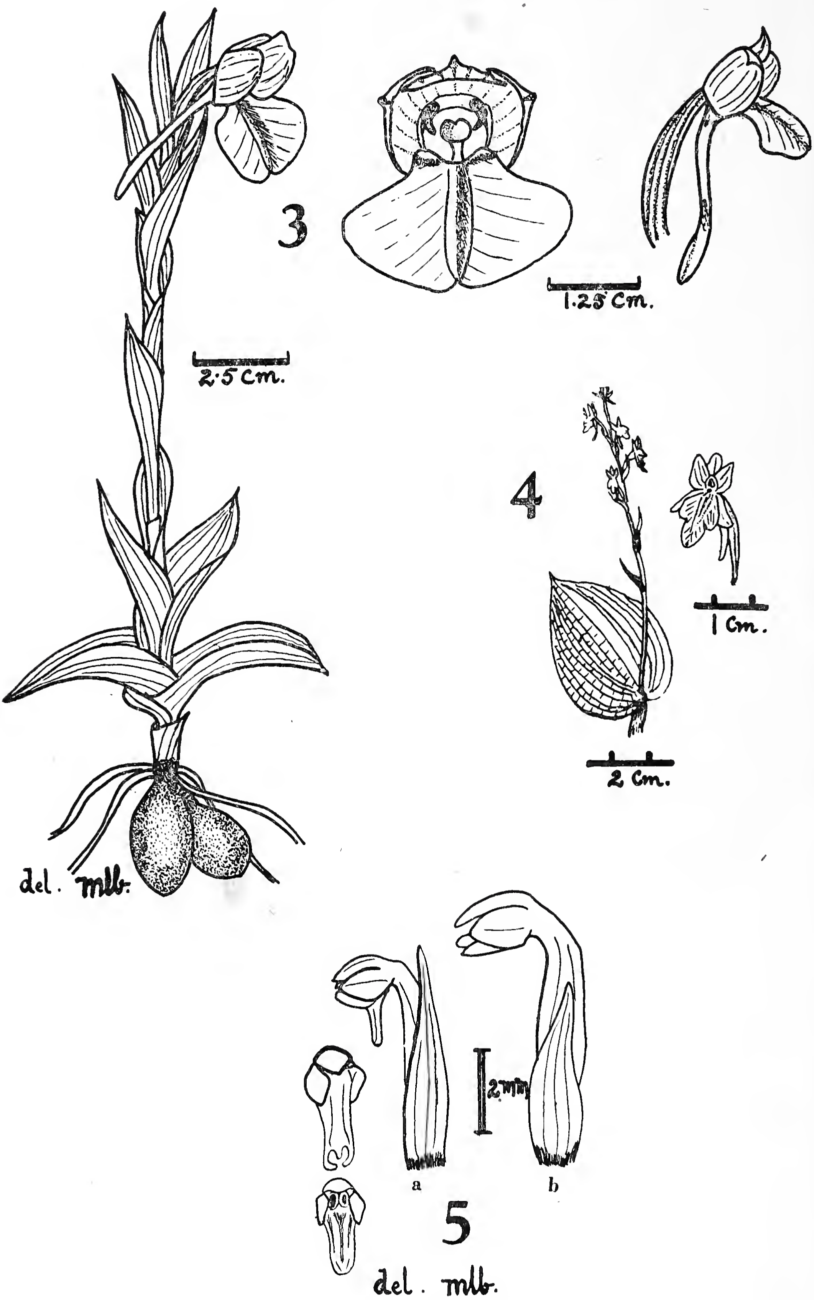

Fig. 3. *Habenaria triflora* D. Don. Fig. 4. *Hemipilia cordifolia* Lindl. Fig. 5. Flowers of *Herminium angustifolium* (Lindl.) Benth. a. normal flower; b. abnormal (peloric) flower.

ing to Hawkes, the flowers closely simulate, superficially atleast, some sort of *Habenaria*. However, they are terrestrial, tuberous herbs with a single broad radical leaf. The flowers are in lax racemes. The lip is obscurely 3 lobed, and the spur is trumpet-shaped.

Hemipilia cordifolia Lindl. Gen. et Spec. Orch. 296, 1835; F.B.I. 6: 167, 1890; Kitamura, 103, 1955. (Fig. 4).
Plants 16-20 cm high, bearing a single leaf at the base. Leaf 7-8 by 4.5-6.5 cm broadly ovate, fleshy. Racemes few to many flowered, flowers purple *c* 1.0-1.5 cm across. Bracts about half the length of the ovary, sepals equal in length, dorsal sepal oblong, obtuse, erect, lateral sepals spreading, falcate, oblong petals smaller than the sepals, erect, forming a hood, broadly ovate, entire. Lip obscurely trilobed, sidelobes rounded, midlobe broad, subcrenate, spur shorter than the ovary, curved, tip faintly 2-lobed upturned. Flowering during August and September. Collected from Tarebhir-Manichur area, Gurmurang (Kitamura). Distributed at 1825 m.

Herminium R. Br.

Herminium is a genus of mostly small flowered, rather insignificant terrestrial orchids. Although rare in cultivation these allies of *Habenaria* Willd. are attractive. Plants are small, erect, tuberous herbs with oblong tubers and with a solitary or few leaves. The Herminia can be distinguished from Habenarias by the characteristic lip, which is never with a spur but is provided with a saccate or gibbous base. Although it is mentioned by Hooker that the Indian Herminia attain the greatest elevation of any orchid, we have not collected any member from a high altitude.

Artificial key to the species of *Herminium*

Lip distinctly 3 lobed -
- Lip deeply 3 lobed near the apex .... *angustifolium*
- Lip 3 lobed near the base and very minute .... *jaffreyanum*

Lip quite entire (sidelobes very faint) –
- Sides of lip dilated, lip longer than sepals, flowers *c* 3-4 mm in diam., green .... *congestum*
- Sides of lip not dilated, lip shorter than sepals, flowers *c* 2-3.5 mm in diam., yellowish .... *monophyllum*

Herminium angustifolium (Lindl.) Benth. ex Hk. f. in Fl. Brit. Ind. 6:129, 1890; King & Pantl. 332, t. 434, 1898; Kitamura, 103, 1955; Hara, 439, 1966. *Aceras angustifolia* Lindl. Gen. et Spec. Orch. 282, 1835. (Fig. 5).
Spike 5-10 cm long, flowers decurrent, small, 1.5 cm in diam., sepals oblong, obtuse, dorsal sepal and petals forming a hood, petals linear,

very narrow, 1 nerved, acute, membraneous. Lip as long as the sepals, trifid beyond the middle, sidelobes filiform, curved, longer than the midlobe, midlobe very short. Flowering during July and August. Collected from Pheda to Charikot, Manichur, Sheopuri area, Aga (Kitamura). Distributed at 2050 to 2400 m.

H. congestum Lindl. Gen. et Spec. Orch. 305, 1835; F.B.I. 6:130, 1890; King & Pantl. 355, t. 440, 1898; Kitamura, 103, 1955.
Spike 3-7 cm long, dense flowered, flowers minute, *c* 3-4 mm in diam., decurved, sepals, obtuse, dorsal sepal broadly ovate to orbicular, lateral sepals oblong to broadly oblong, petals ovate, equalling the sepals, fleshy. Lip entire, ovate or triangular-ovate, fleshy, sides faintly dilated into lobes, base saccate. Authority Kitamura.

H. jaffreyanum King & Pantl. in Journ. Asiat. Soc. Beng. 65:130, 1895; et Orch. Sikkim Himal. 333, t. 436, 1898.
Spike 3.5-7.5 cm long, densely flowered, flowers 2-2.5 mm in diam., sepals broadly ovate-elliptic, concave, slightly spreading, petals narrowly oblong, obtuse, longer than the sepals. Lip 3 lobed near the base, side lobes very small and rounded, midlobe elongate with a blunt apex. Flowering during August and September. Collected from Charikot-Kalinchok area at 3200 m. This species can be distinguished from *H. angustifolium* on the characters of the lip and sepals. It also resembles *H. monophyllum* which has a single leaf, floral bracts are longer than the flowers, and the lip is entire.

H. monophyllum (D. Don) P. F. Hunt & Summerhayes in Kew Bull. 20(1):51, 1966. *Neottia monophyllum* D. Don, Prodr. Fl. Nep. 27, 1825. *Herminium gramineum* Lindl. Gen. et Spec. Orch. 305, 1835; F.B.I. 6:131, 1890.
Spike lax flowered, flowers minute *c.* 2-3.5 mm in diam., yellowish, suberect, dorsal sepal oblong or broadly ovate, lateral sepals ovate, obtuse, spreading, petals erect, linear, falcate, as long as the sepals, thick. Lip flat, ovate, acuminate, equalling or shorter than the sepals, base concave, saccate. Flowering during August. Collected from Chaubas to Risingo, Buludanda to Risingo, Tarebhir. Common at 1985 m

Platanthera L. C. Rich.

This is a group of terrestrial orchids which are sometimes included in *Habenaria* Willd. from which it is separated on technical data. The name refers to the unusual width of the anthers.

Artificial key to the species of *Platanthera*

Lip pectinate, petals smaller than the sepals.................. *susannae*
Lip entire and blunt, petals equalling the sepals.............. *bakeriana*

Platanthera bakeriana (King & Pantl.) Kraenzl. Orch. Gen. et Spec. 1:611, 1898; Hara, 448, 1966. *Habenaria bakeriana* King & Pantl. in Jorun. Asiat. Soc. Beng. 65:132, 1895 et Ann. Roy. Bot. Gard. Calc. 314, t. 413, 1898; Hara, 189, 1971.
Spike 10-15 cm long, laxly flowered; sepals oblong-lanceolate, dorsal sepal conniving with the petals forming a hood, lateral sepals reflexed, petals as long as the sepals, broadly ovate, oblique, subacute, base broad. Lip fleshy, oblong, blunt, slightly broader towards the base, entire, equalling the lateral sepals, spur long, slender, twice as long as the ovary, curved forwards. Collected from Phulchowki.

P. susannae (Linn.) Lindl. Gen. et Spec. Orch. 295, 1835; Sant. in Rec. Bot. Surv. Ind. 16(1): 305, 1953, Sant. & Kapad. in Journ. Bomb. nat. Hist. Soc. 57(1): 125, 1960. *Orchis susannae* Linn. Sp. Pl. 939, 1753. *Habenaria susannae* (Linn.) R. Br. ex Spreng, Syst. Veg. 3:622, 1826; F.B.I. 6:137, 1890; Holttum, 81, f. 13, 1955.
Flowers few and large, *c* 7.5-10 cm in diam., white, fragrant, sepals spreading, lateral sepals 3.6 by 2.4 cm, oblong, subquadrately ascending, obtuse, edges reflexed, dorsal sepal broad, rhomboid, spreading, petals small, linear, 1.5 cm long, acute. Lip not longer than the sepals, 3 lobed near to the base, sidelobes truncate, pectinate, midlobe 3 cm long linear or dilated downwards, spur twice as long as the ovary, 10-12 cm long. Flowering during August and September. Collected from Markhu, at *c*. 1525 m.

Satyrium Sw.

Terrestrial leafy erect orchids with the root system consisting of several ovoid or globular tubers with numerous fleshy roots. When the large tubers perish after producing the flowering stem, the smaller tubers gradually increase in size, and later produce flowering stems. Because of the presumed aphrodisiacal properties possessed by the tubers the plants are much sought after and possibly it is for this reason that plants of *Satyrium nepalensis* are rather rare in the surroundings of Kathmandu valley.
Satyrium nepalensis D. Don, Prodr. Fl. Nep. 26, 1825; F.B.I. 6:168, 1890; King & Pantl. 338, t. 444, 1898; Kitamura, 104, 1955.
Flowering stem even up to 60 cm long, flowers crowded, *c*. 8-16 mm in diam., from dark pink to white, fragrant, sepals linear oblong, obtuse, spreading and recurved, petals rather narrower than the sepals. Lip broadly oblong, concave, strongly keeled on the back, spurs two, longer than the sepals and as long as the ovary. Flowering during September and October. Collected from Chandragiri, Chaubas to Risingo, Nayapati to Risingo, Rolkhani to Tamchee, Kokwa (Kitamura), Bangukhola (Kitamura). Distributed between 2250 to 3500 m.

var. **ciliata** King & Pantl. 339, 1898. *S. ciliatum* Lindl. Gen. et Spec. Orch. 340, 1835.

Spur hardly longer than the sepals. Collected from Tarebhir to Nagi, Borlong forest at 1980 m.

forma **albiflora** has been described by Tuyama in Hara's Fl. Eastern Himal., but we are of the opinion that there is a great variation of colour, thus a *forma* on colour is not proper. However, plants with light pink flowers which were collected from Godavari Botanic Garden, Kathmandu, were grown in the Indian Co-operation Mission, Kathmandu garden and during the following year the flowers that appeared had a deeper colour. King & Pantl. (loc. cit.) have also mentioned that occasionally flowers are pure white.

(*to be continued*)

A new species of spider of the genus *Cheiracanthium* Koch (Family Clubionidae) from India[1]

B. K. TIKADER

(With four text-figures)

The Spiders of the family Clubionidae are little known in India, I have described previously (1962) a single species of this genus *Cheiracanthium* and subsequently Patel & Patel described a second species (1973). This is the third species to be described from India. While examining the spider collection received from Shri J. C. Daniel, Curator, Bombay Natural History Society, I came across a new species of spider, of the genus *Cheiracanthium*, which is described here.

Cheiracanthium danieli sp. nov.[2]

General: Cephalothorax and abdomen light brownish-green, legs pale-green. Total length 6.30 mm. Carapace 3.00 mm long, 2.20 mm wide; abdomen 3.40 mm long, 1.80 mm wide.

Cephalothorax: Longer than wide, wider in front, clothed with fine hairs, moderately convex, cephalic region slightly higher than posterior region. Eyes pearly white, anterior row straight and posterior row procurved; lateral eyes nearly contiguous; medians oval and white, slightly larger than laterals. Chelicerae strong, nearly vertical and dark brown in colour, inner margin provided with two equal teeth but other margin with one tooth large and another very small. Maxillae and labium (Fig. 2) provided with deep brown colour. Sternum heart-shaped pointed behind, clothed with hairs. Legs long, stout, clothed with hairs. Femora I and II provided with a dorsal long spine. Male palp as in text fig. 4.

Abdomen: Rather long, narrowed posteriorly, clothed with pubescence and some long hairs. Ventral side uniform pale colour. Epigyne as in text fig. 3.

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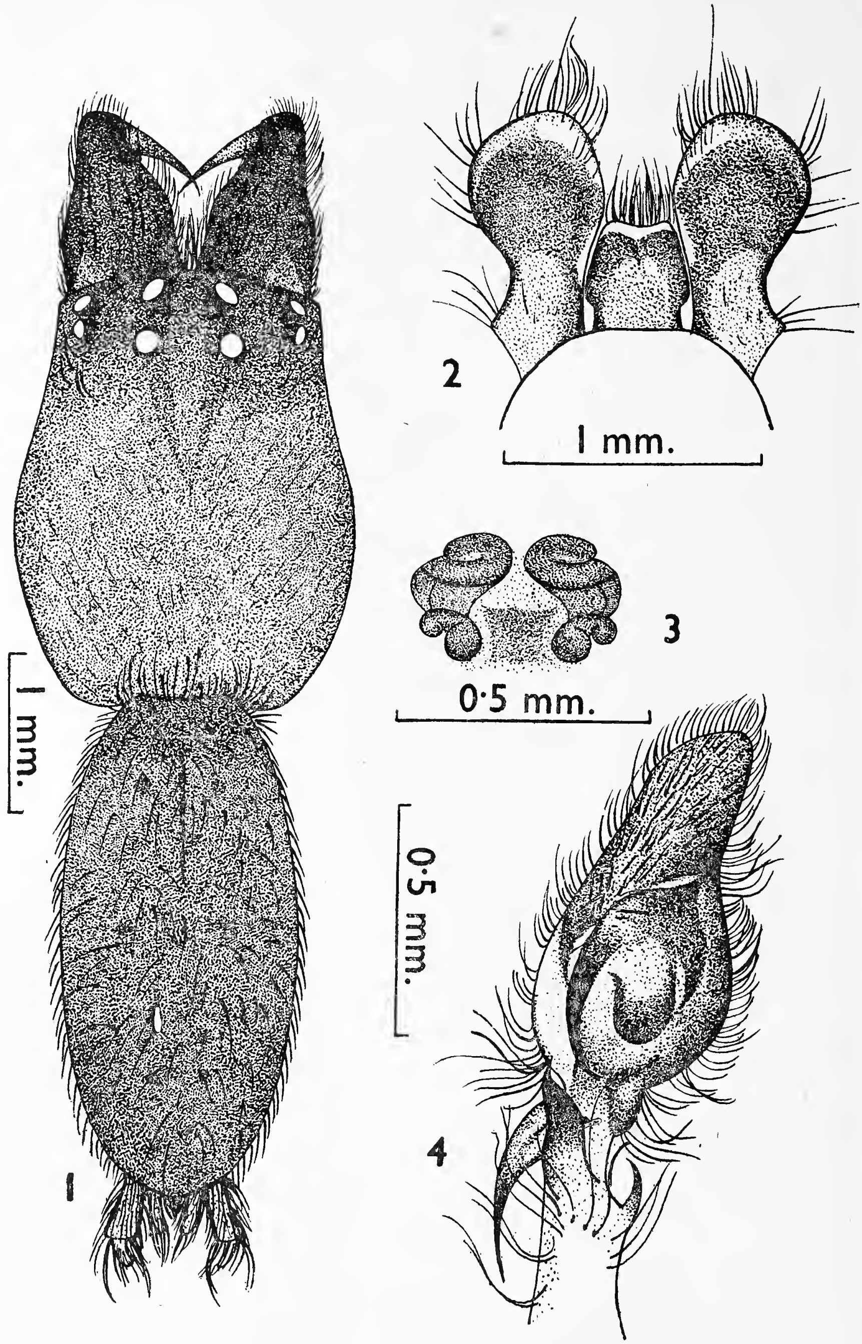
[1] Accepted February 20, 1974.

[2] It is with much pleasure that I have named this species after Shri J. C. Daniel, Curator, Bombay Natural History Society, who collected this specimen for my study.



Cheiracanthium danieli sp. nov.

Fig. 1. Dorsal view of female, legs omitted. Fig. 2. Maxillae and labium. Fig. 3. Epigyne. Fig. 4. Male palp.

Holotype: One female, *allotype* one male in spirit.

Type locality: Borivli National Park, Bombay, India *Coll.* J. C. Daniel. 25.i.1974 and *allotype* from Western Regional Station, Zoological Survey of India, Shivajinagar, Poona - 5 *Coll.* B. K. Tikader, 31-i-1974.

This species resembles *Cheiracanthium saraswatii* Tikader, but it is separated as follows: (i) Chelicerae, maxillae and labium conspicuously dark brown in colour, but in *C. saraswatii* chelicerae, maxillae and labium not conspicuously dark brown colour. (ii) Epigyne and male palp structurally different.

References

Patel, B. H. & Patel, H. K. (1973): On some new species of spiders of family Clubionidae (Araneae: Arachnida) with record of genus *Castineira* Keyserling from Gujarat, India: *Proc. Indian Acad. Sci. 78*(1):1-9.

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Some observations on birds at high altitude lake sides in Gosainkund, central Nepal[1 & 2]

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(*With a map*)

Simple bird censuses by the line transect method were carried out by the side of high altitude lakes, at about 4,300 m altitude in Gosainkund, central Nepal on June 4-5, 1968. In total, ten species and a few unidentified ones were noted in the cirque. Another five species were observed outside of the census areas. The status of each species at high elevations in Gosainkund is briefly described together with previous records from central Nepal. The average bird density around the lakes was 13.5 per hour or 4.5 per ha. An unusually high density of 54.0 per hour or 18.1 per ha. was recorded on 4 June. This high concentration probably was due to a temporary fall of snow. The density of birds at the lake sides seemed to be higher than that of other areas, excluding tarns or streams, at the same altitude in Gosainkund.

Since the middle of the last century reports on the distribution of birds in Nepal have been published by many authors such as Gray & Gray (1846), Scully (1879), Smythies (1948, 1950), Proud (1949, 1952, 1955), Ripley (1950), Rand & Fleming (1957), Fleming & Traylor (1961, 1964), Fleming (1968), etc. Recently Biswas (1960-1966) has compiled serial catalogues of birds known from Nepal based upon a bibliographical survey and his original observations. But there are few ecological observations except the important work by Diesselhorst (1968) and no record on the actual abundance of Nepalese birds has yet been given at all.

From March to July 1968, I had an opportunity to observe many birds from the tarai up to the alpine zone in central Nepal and on the Kali Gandak watershed in west-central Nepal[3] as a member of the Hokkaido University Scientific Expedition to Nepal Himalaya 1968. While trekking in the country, I tried to census birds in different

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[1] Scientific results of Hokkaido University Expeditions to the Himalayas, Zoology No. 5.

[2] Accepted February 28, 1973.

[3] Divisions of Nepal used here conform to the usage by Biswas (1960).

habitats. The present paper deals with results obtained at the highest altitude the party reached.

Habitat and Methods

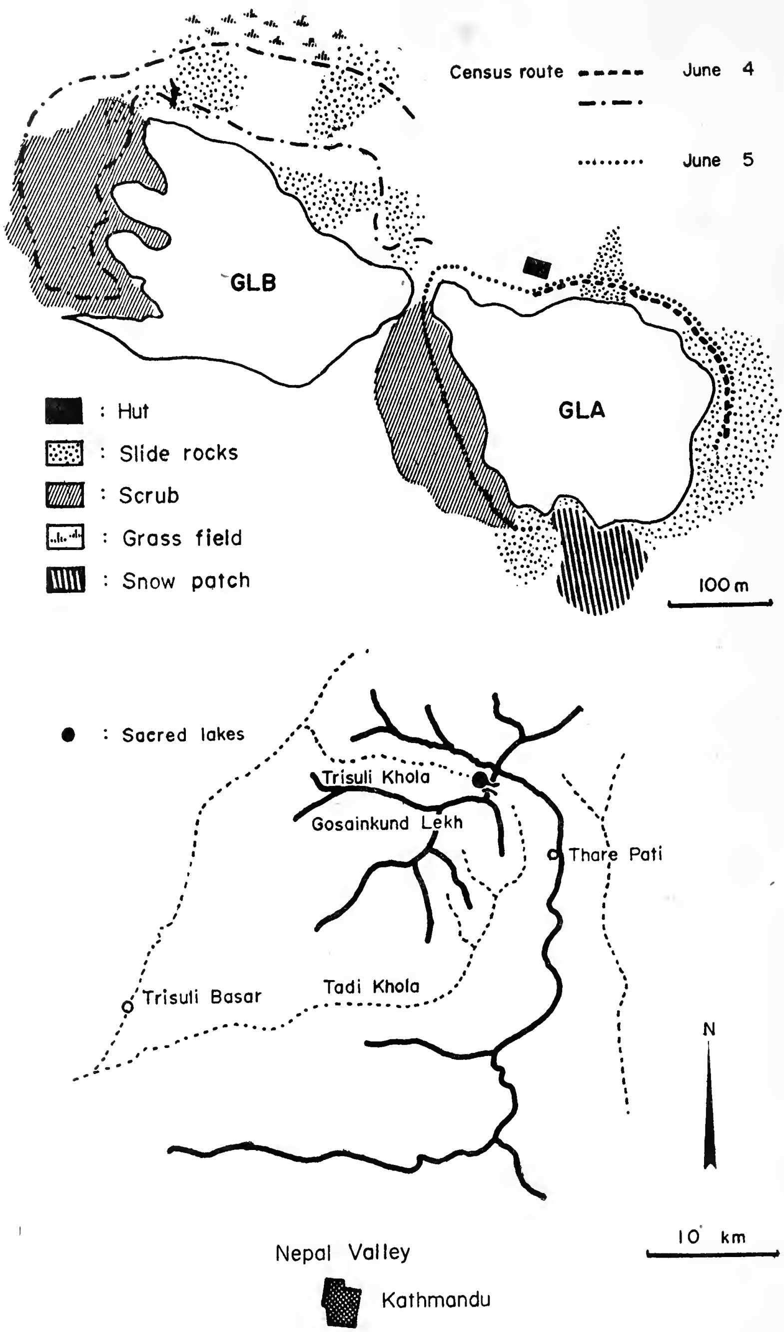
The Gosainkund Lekh lies at about 40 km northwards of Kathmandu, the capital of Nepal. Beneath its crest are seven or more montane tarns at the head of the Trisuli Khola. Trekking along the trail running upwards to the pass from the Tadi Khola, I came across only six small lakes, the upper three of which were completely frozen. Beside a clear lake at an elevation of about 4,300 m, some huts and an altar with standing tall flags (*tarcho*) were situated on a slope of debris. This was the famous sacred lake. Three fourth of its circumference was encircled by steep rocky inclines and water fell from a northwestern opening down to a lower lake through a cascade of several metres.

These lakes are henceforth abbreviated as GLA and GLB respectively. Accurate measurements of size and shape of both lakes were not secured, but the circumference was estimated to be about 850 m in GLA and 1,200 m in GLB (Map).

The slopes around the lakes were barren rock slides extending upwards from about 4,000 m (a few shrubs of rhododendrons were still occasionally seen). The western sides of both lakes were covered with dwarf rhododendron scrub; *R. anthopogon* with pale yellow-white flowers and *R. setosum* with pink-rose ones past full bloom. Besides these, the surroundings were covered with meagre patches of vegetation composed of *Primula* and *Potentilla* both in bloom, mosses, lichens, and withered sedges. Nematocera, *Carabus, Lacon, Eubasilissa nepalensis* and small dung beetles were found under or on the debris of the water's edge and many active long-legged flies, *Hydrophorus,* on the snow. Some earthworms and centipedes were also found under stones on the scree. Although the quantity of these insects was not accurately measured at each lake side, food for birds was apparently more abundant at GLA than GLB.

Birds were counted twice at the side of GLA and once at GLB by line transect method. At first all birds encountered along the GLA side, covering about 300 × 50 m, were recorded from 8.00 to 8.30 on June 4. It was cloudy but sometimes fine and the light snow that fell overnight was 4-6 cm deep. Air temperature was 2°C at 8.00. The next day was cloudy and the snow in the area had almost thawed. Air temperature was 0.5°C at 6.00 and the second count was carried out from 6.30 to 7.30, covering 600 × 50 m along the water side.

All birds were counted near the GLB, covering 1,200 × 50 m, from 15.45 to 18.00 on June 4. On the way the census had to be stopped



Map. Sketch map of Gosainkund and sacred lakes.

for about three quarters of an hour due to heavy rain-fall and dense fog. Air temperature was 6.5°C at 15.15.

Results

Birds encountered during each census are arranged in Table 1. Absolute number counted, dominance, average density per unit time and area in each species are shown in Table 2, omitting the result of the first census which was somewhat peculiar as described in the conclusion.

Most of the birds observed were moving about or searching for food among the rocks at the water's edge, excepting the following individuals: Two *Prunella* preening on rocks away from the water, and two flying towards the scrub of dwarf rhododendrons; four *Anthus hodgsoni* flying over the lakes, two of them holding worms or something similar between their bills, and one calling from a rock and another doing so on the wing; *A. cervinus* giving the alarm call from a stone wall; a pair of *Leucosticte* hopping on the small grass field; one *Chaimarrornis* often driving away an *Anthus* from the debris, and two passing over the lake at about 2 m high; two male *Monticola* chasing each other on the rock slide; a *Zoothera* taking insects or worms on the ground under the shade of a large rock; two *Tadorna* coming from southwest and flying away towards the eastern crest of the ridge after circular flights at about 20 m height over my head; a female *Aythya* floating at the margin of GLB (not seen anywhere next morning); all birds of uncertain identification were flying rapidly between the rocks or high overhead.

The status of each species at high altitude in central Nepal is briefly outlined below. These comments are based upon both original observations and previous records.

Prunella collaris nipalensis (Blyth): Eastern Alpine Hedge Sparrow.

Three male specimens collected after the census were all *nipalensis*. This subspecies seems to be reported only in central Nepal after Hodgson's collection; that is Smythies' observation on the Gandak-Kosi watershed at 4,570 m in September. But it was the most dominant and common bird along streams and tarns at 4,160-4,500 m in the area observed along the pilgrim trail.

On June 5, I recorded four birds of this species beneath the pass hopping on rocks near the frozen lake at 4,500 m, another two birds were each on different streams at 4,250-4,220 m and finally one was searching for food on the ground of the cirque at 4,160 m at the head of the Tadi Khola. Three specimens obtained there had already enlarged testes, 11-14 × 16-20 mm, indicating that they were just in season.

TABLE 1

NUMBER OF INDIVIDUALS, DOMINANCE AND DENSITY OF ALL SPECIES OBSERVED IN EACH CENSUS.

	Census round GLA								Census round GLB			
	First				Second							
Species			Density per				Density per				Density per	
	N	D	hour	ha	N	D	hour	ha	N	D	hour	ha
P. collaris	12	44	24.0	8.0	5	28	5.0	1.7	6	25	2.8	1.0
A. roseatus	6	22	12.0	4.0	3	17	3.0	1.0	3	13	1.4	0.5
A. hodgsoni	4	15	8.0	2.7	2	11	2.0	0.7	2	8	0.9	0.3
A. cervinus	2	7	4.0	1.3					2	8	0.9	0.3
C. leucocephalus	1	4	2.0	0.7	2	11	2.0	0.7	4	17	1.9	0.7
L. nemoricola					2	11	2.0	0.7	2	8	0.9	0.3
M. rufiventris									2	8	0.9	0.3
Z. mollissima	1	4	2.0	0.7								
T. ferruginea					2	11	2.0	0.7				
A. fuligula									1	4	0.5	0.2
Uncertain	1	4	2.0	0.7	2	11	2.0	0.7	2	8	0.9	0.3
Total	27	100	54.0	18.1	18	100	18.0	6.2	24	100	11.1	3.9

N: Number of individuals.
D: Dominance (%).

TABLE 2

TOTAL NUMBER OF INDIVIDUALS, AVERAGE DOMINANCE AND DENSITY OF CENSUSES EXCEPT THE FIRST ONE AT GLA.

Species	No. of individuals	Dominance (%)	Density per hour	Density per ha
P. collaris	11	26.2	3.4	1.2
A. roseatus	6	14.3	1.9	0.7
A. hodgsoni	4	9.5	1.3	0.4
A. cervinus	2	4.8	0.7	0.2
C. leucocephalus	6	14.3	1.9	0.7
L. nemoricola	4	9.5	1.3	0.4
M. rufiventris	2	4.8	0.7	0.2
T. ferruginea	2	4.8	0.7	0.2
T. fuligula	1	2.4	0.3	0.1
Uncertain	4	9.5	1.3	0.4
Total	42	100	13.5	4.5

The individuals caught by Diesselhorst (1968) in eastern Nepal from late June to mid August also had well developed gonads and he suggested that their breeding would begin in June.

Anthus roseatus Blyth: Hodgson's Pipit.

Smythies (1948) did not come across this bird at Gosainkund in autumn, though Scully (1879), Proud (1955), and Rand & Fleming (1957) found it not uncommon in the Nepal Valley in winter and Polunin (1955) recorded it as abundant at about 3,000 m up in central Nepal in summer. It seems to be common at about 4,300-4,700 m in west-central Nepal (Lowndes 1955) and breeds in the alpine zone in Nepal (Biswas 1960; Diesselhorst 1968).

I came across these birds at 4,160-4,300 m in Gosainkund. A specimen caught around the lake had developed testes 8 × 5 mm, and many bits of insects, mostly broken Nematocera, were found in its stomach.

Anthus hodgsoni Richmond: Indian Tree Pipit.

It is not prudent to identify this as *A. h. yunnanensis* or *A. h. hodgsoni,* but all previous records on the former indicate that it occurs below 3,000 m while *hodgsoni* seems mainly to breed at the higher altitude of 3,000-4,000 m in Nepal (Diesselhorst 1968).

Anthus cervinus Pallas: Redthroated Pipit.

This species seems to be scarce in Nepal; after Hodgson's collection there are neither sight records nor collected examples except a single one obtained by Rand & Fleming (1957). The author, however, met with several individuals of this species at 4,220-4,350 m and they could be apparently distinguished from other pipits found in the same area by means of their bright cinnamon-red supercilium, throat and breast, especially in comparison with the vinous-pink *roseatus.*

Chaimarrornis leucocephalus (Vigors): Whitecapped Redstart.

Three or four birds were sometimes flying about our camping place. This was a bird characteristic of streams or tarns as already noted by Smythies (1948) at the eastern side of Gosainkund. These birds, uttering short notes, were observed up to 4,480 m on June 5 and were also common in the cirque beyond the pass to the Tadi Khola.

Zoothera mollissima (Blyth) or **dixoni** (Seebohm): Plainbacked or Longtailed Mountain Thrush.

This thrush was very rare in the alpine zone. This sight record was insufficient to positively identify the bird as *mollissima* or *dixoni,* but it may furnish information. Diesselhorst (1968) pointed out the possibility of their ecological segregation with *dixoni* in forest and *mollissima* in the alpine or over the forest zone. In eastern Nepal he occasionally found "Zoothera Drosseln" at 4,300-4,400 m in habitats such as rock slide areas and poor vegetation without trees similar to habitats in my survey.

This species has been reported from central Nepal only at 1,500-3,600 m by Smythies (1948, 1950), Proud (1955), and Rand & Fleming (1957). The present case, however, may be the first sight record at such a high altitude in central Nepal. Abe, a member of the party, also recognized a similar *Zoothera* near the lake in the afternoon.

Leucosticte nemoricola (Hodgson): Hodgson's Mountain Finch.

Moved in pairs. Neither Smythies (1948) nor Proud (1952) found this species at the Gandak-Kosi watershed, but Polunin (1955) obtained it in the Langtan Khola, central Nepal. Diesselhorst (1968) enumerated it as a typical alpine bird in Nepal and Martens (1971) found it at about 3,000 m in non-breeding season.

Tadorna ferruginea (Pallas): Ruddy Sheld-duck or Brahminy Duck.

Scully (1879), Ripley (1950), and Rand & Fleming (1957) recorded it as common in the tarai and occasional in the Nepal Valley. I saw no other individuals in the country. This case might be a rare sight record at this high altitude in central Nepal. Biswas (1960) reported that he found this species preparing to breed at about 5,000-5,300 m, but Diesselhorst (1968) conservatively admitted its probable propagation, considering the impossibility of its usual breeding activity at those alpine lakes.

Monticola rufiventris (Jardine & Selby): Chestnutbellied Rock Thrush.

The individuals observed seemed to be *rufiventris,* because no white patches on wings characteristic of *cinclorhynchus* were seen. A pair was seen near the frozen tarns at 4,460 m and the male was singing loudly on a rock. Moreover, a pair calling and moving around on rock debris at 4,250 m was found beyond the pass on the way to Thare Pati. Hitherto the species has been recorded only below 3,350 m in autumn (Smythies 1948) and 2,440 m even in spring (Proud 1952) in central Nepal.

Aythya fuligula (Linnaeus): Tufted Duck.

Ripley (1950) found it in ponds and on the rivers around the Nepal Valley and it seems to be fairly common in the lowlands during winter (Rand & Fleming 1957). Masatomi (1971) found four males and six females floating on a pond near Trisuli at about 700 m on May 28. The occurrence of the species may be very uncommon at such high altitude in central Nepal, but Biswas (1960) observed it on montane lakes at about 5,000-5,300 m in eastern Nepal in May.

Besides the birds mentioned above, the following species were occasionally found around the sacred lakes during 3-5 June.

Myiophoneus caeruleus (Scopoli): Whistling Thrush.

Noted resting for a moment on rocks near the lake side, then it flew north towards the ridge. Smythies (1948) did not mention it in his list, but Proud (1955) and Polunin (1955) found it up to only 3,500 m

in central Nepal. On the way to Thare Pati at 3,800 m, I saw another.

Grandala coelicolor Hodgson: Hodgson's Grandala.

One male on June 5. After stopping a while on rocks it flew away northwards. A flock of this typical alpine species feeding on scree was found in a cirque and three specimens were collected at the head of the Tadi Khola at 4,160 m. A female obtained had a fully developed egg with a soft shell in her uterus. Smythies (1948) saw it at about 4,500 m in the same area and Diesselhorst (1968) caught specimens at 4,100-5,200 m in eastern Nepal.

Carpodacus puniceus puniceus (Blyth): Nepal Redbreasted Rosefinch.

A female was obtained near the Kharka on June 3. On the Gosainkund Lekh only Smythies (1948) observed a male at about 3,650 m in September.

Partridge and kite.

The call notes of snow partridges were heard several times from the upper margin of the northern cliff rising at a distance from the lake, though I failed to find them in the fog. On June 4 a bird, probably a kite passed over the ridge far from me, gliding in a southerly direction.

Conclusion

The avifauna of the area observed in early June 1968 were characterized by the most dominant alpine hedge sparrow, *P. collaris*, previously recorded at 4,570 m on the Gosainkund Lekh (Smythies 1948). The next abundant birds were subalpine or alpine pipits, *Anthus* group, and the redstart, *C. leucocephalus*, occuring up to 5,335 m in summer (Biswas 1961). The others were typical alpine birds, that is, the grandala and the mountain finch. Though Diesselhorst (1968) listed six species as common dwellers in a restricted vertical range in "Feuchte alpine Gebusche und Matten" 4,200-5,200 m, only three of them, *P. collaris, A. roseatus,* and *L. nemoricola* were found common at the lake sides in the present case.

Appearance of ducks at such high elevations might be rare but partly relates to the existence of tarns in the area. They must stay here only temporarily, for they did not appear to be breeding here.

It was remarkable that the results of first census made on June 4 showed a concentration of birds more than three or four times denser than in other cases. Particularly *Prunella* and *Anthus* were abundant at GLA; about five times as many as on the next day. Although these unusual results might depend partly on the difference of census time, they must have been caused mainly by the snow fall on June 4 which temporarily covered all fields and made food hard to get for the birds.

In fact, after much of the snow had thawed by afternoon, I found birds on the rocky slopes studded with grassy patches a little distance from the lake. Few birds had been counted here during the first census.

The density at GLA seemed to be slightly higher than that at GLB. Analysis of both habitats were not sufficient to specify the factors causing such different congregations, but as described above many more insects were found at GLA, especially at the northern side, than at GLB. The comparison of individual numbers of birds at the different sites seems to be of less significance statistically, because the number of censuses was small and the conditions were fairly different.

The relative abundance of individual numbers in this census at this high altitude might be caused by birds wandering up to their breeding grounds. *C. leucocephalus,* for example, was not seen above 1,500 m in late March on the Gandak Kosi watershed by Proud (1952), but I recognized it as common up to about 4,500 m as Smythies (1948) found it in September. Naturally the population at the area may decrease in winter owing to freezing and snowfall covering all fields.

Although an actual count at other places at similar altitude was not undertaken, I felt that rocky slopes, excluding tarns or streams, had fewer birds than the area censused. Therefore, the number of birds recorded in the present case might indicate not the average (or the lowest) but more or less high (or the highest by Elton, 1933) density at this altitude in Gosainkund.

Acknowledgements

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A new species of *Rotala* from Palghat, Kerala[1]

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(*With eighteen text-figures*)

The plant described in this paper is a new species of *Rotala,* collected first in August, 1964, from Malampuzha, Palghat, Kerala State, and subsequently from other places. Details of collection are shown below.

Date	Place	Habitat	Association
August 1964	Malampuzha, Palghat Dt.	Very shallow water holes on granite rock.	As consociations or along with *Dopatrium, Ilysanthes.*
September 1965	N. Parur, Ernakulam Dt.	Water-logged sandy loam soil.	Small consociation.
September 1967	Badagara, Calicut Dt.	Paddy fields.	Along with *Rotala leptopetala, R. densiflora, Limnophila.*
July 1971	Malampuzha, Palghat Dt.	Very shallow water holes on rock.	Consociation or along with *Dopatrium, Ilysanthes.*

The plants formed dense, deep green carpets on the substratum. The gregarious growth and short, slender, simple erect branches with crimson spots of flowers and fruits made the plants conspicuous and different in appearance from the larger species, *Rotala leptopetala* and *R. densiflora,* which were also common in the locality. The latter two species are not spreading forms and their erect shoots freely branch. Because of striking differences from all other species of *Rotala* recorded from this state, dry specimens and descriptions were sent to Royal

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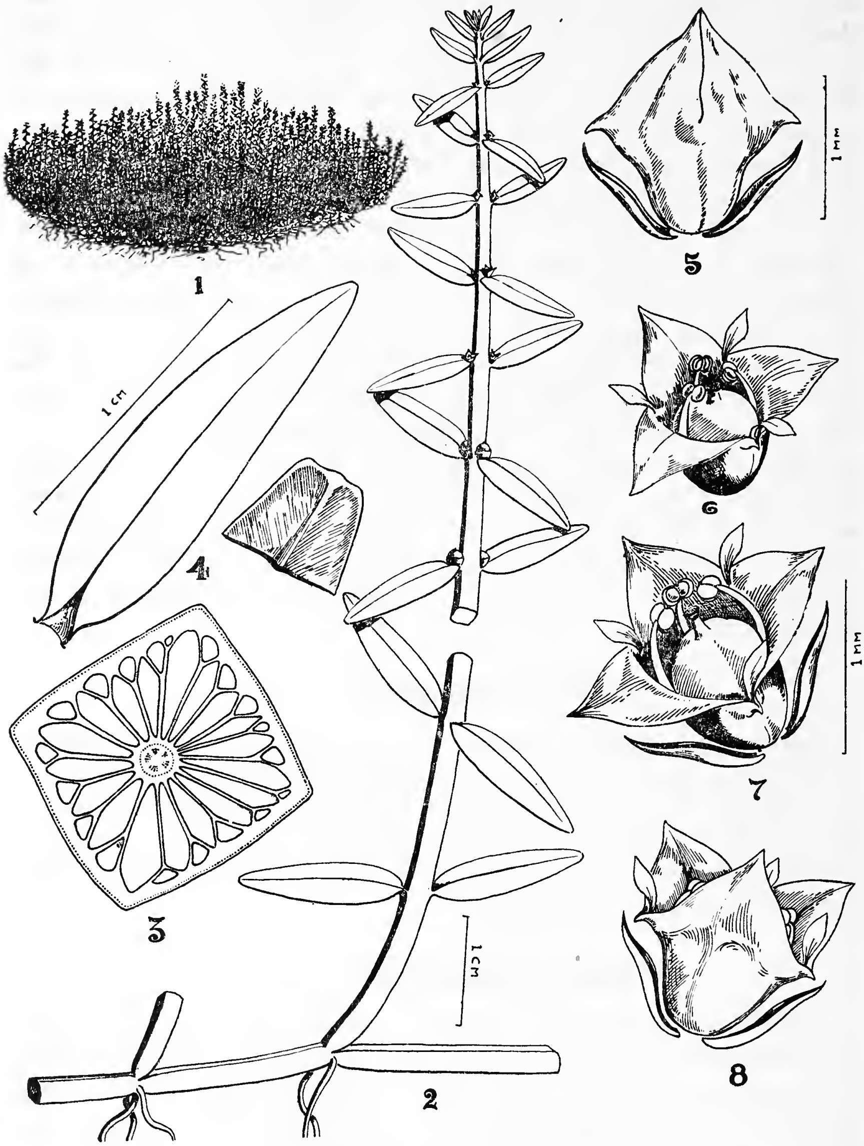
Botanic Gardens, Kew, for identification (H. 868/68) where it was identified as a form of *Rotala* cf. *R. leptopetala*. Study of fresh specimens with reference to original diagnosis given by Koehne for the sub-species and varieties of *R. leptopetala,* proved that this plant is a distinct type. Due to the peculiar spreading growth and short, simple erect branches, the plant is easily distinguished from the other species of *Rotala,* even in the vegetative stage. Trimerous flower, staminodes, and reduced number of seeds are three characteristics of the plant, separating it from the other species. Hundreds of fresh flowers of *R. leptopetala* collected from different localities were examined. Staminodes or anything suggestive of staminodes were not found in any. But staminodes are invariably present in this plant. The characters of this plant are constant. Specimens from the three localities which are more than 150 km apart and with different environmental conditions, are all alike. Even when growing along with *R. leptopetala,* at the same spot, it is strikingly different. All evidence indicates that it is a separate and unidentified species of *Rotala.* Based on its spreading growth, small size, simple, short, erect branches, crimson trimerous flower, staminodes, and limited number of seeds, it is described as a new species of *Rotala.*

Rotala malampuzhensis sp. nov.

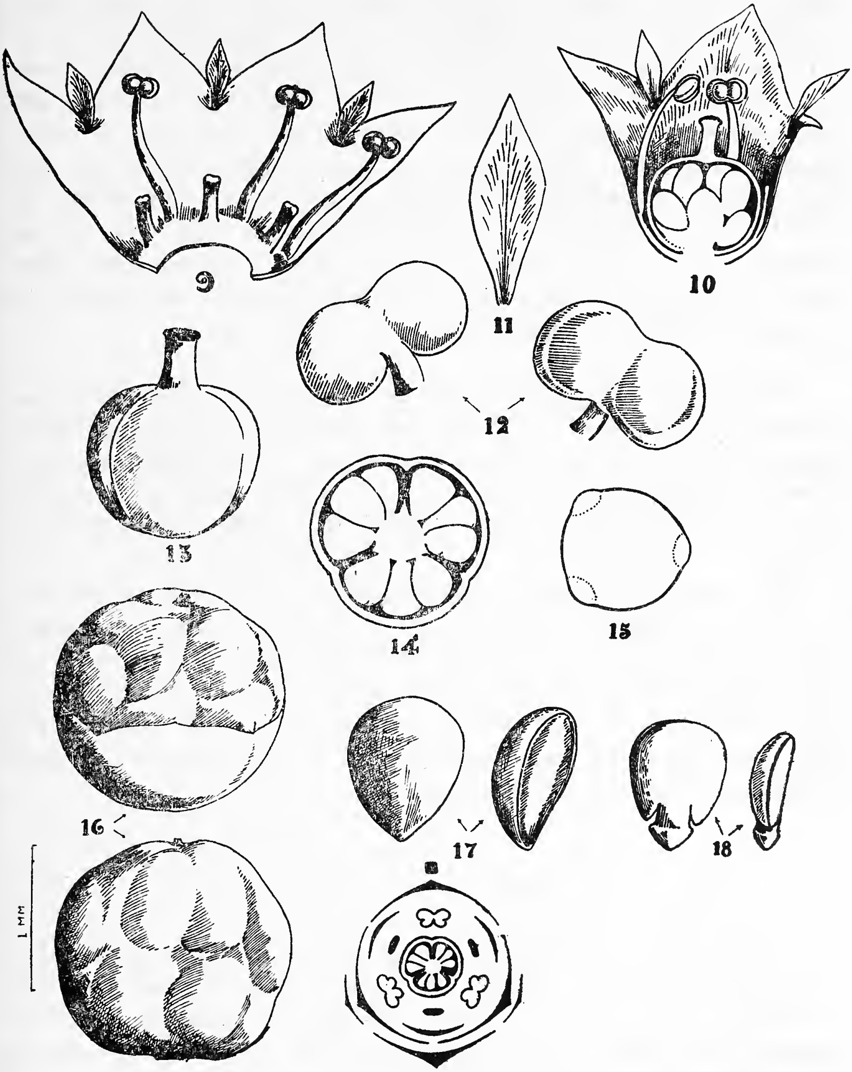
Herba annua amphibia profuse ramosa caespitosa perviridis, floribus et fructibus coccineis minutis sed conspicuis instructa. Rami erecti simplices tenuesque. Folia angustata minus quam 1.5 cm longa, 2-4 mm lata. Flores solitarii axillares coccinei trimeri, minus quam 1.5 mm diametro. Dentes accessorii florum breves deflexi. Petala minuta coccinea. Staminodia 3. Semina 10-15 coccinea.

Rotala malampuzhensis sp. nov.

Amphibious, annual herbs growing as dense, deep green carpet, spotted with crimson flowers and fruits. Stem procumbent, profusely branched, spreading, rooting at nodes; erect branches simple, 5-20 cm long; inter-nodes slender, quadrangular, upper ones short. Leaves simple, exstipulate, opposite decussate, subsessile, angustate, 2-4 mm broad, up to 1.5 cm long, deep green veins indistinct, apex microscopically truncate (Fig. 2). Flowers solitary, axillary (Fig. 1), sessile, crimson, less than 1.5 mm in dia., trimerous, actinomorphic, hermaphrodite, perigynous. Bracteoles 2, lateral, subulate, shorter than calyx (Fig. 3). Hypanthium campanulate, less than 1 mm long, with 6 faint vertical veins. Sepals 3, free, triangular, acute, crimson (Fig. 3, 4). Accessory teeth 3, very short, acute (Figs. 3, 4). Petals 3, free, very small, linear-oblong, acute, crimson (Fig. 11). Stamens 3, antisepalous; filaments filiform,



Rotala malampuzhensis sp. nov.
Fig. 1. Habit; Fig. 2. Twig; Fig. 3. T. S. of stem; Fig. 4. Leaf and leaf-tip; Fig. 5. Bud; Figs. 6, 7, 8. Open flowers.



Rotala malampuzhensis sp. nov.

Fig. 9. Hypanthium opened; Fig. 10. V. S. of flower; Fig. 11. Petal; Fig. 12. Anther in two views; Fig. 13. Pistil; Fig. 14. T. S. of ovary; Fig. 15. Pollen; Fig. 16. Fruits; Fig. 17. Seed in two views; Fig. 18. Embryo in two views.

white or purplish anthers 2-celled, 4-lobed, introrse, cells semicircular, purplish; pollen white, sub-spherical, smooth, thin-walled (Figs. 9, 12, 15). Staminodes 3, alternating with stamens, shorter than ovary, linear, apex purplish, entire, emarginate or slightly bifid (Fig. 9). Ovary sub-spherical, incompletely 3-celled, with vestigial septa only at base; placenta axile, fleshy, discontinuous at apex; ovules 3-6 per cell; style short, simple; stigma discoid, papillate (Figs. 10, 13, 14). Fruits less than 1.5 mm, sub-spherical, crimson, half-exserted (Fig. 16), splitting vertically into 3 valves; pericarp microscopically horizontally striate. Seeds 10-15, crimson, obovoid, inner surface slightly excavated (Fig. 17) smooth, shining, exalbuminous.

Diagnosis

Profusely branching, tufted, deep green plants with minute but conspicuous crimson spots of flowers and fruits. Erect branches simple, slender, short. Leaves less than 1.5 cm long, 2-4 mm broad, angustate. Flowers solitary, axillary, crimson, less 1.5 mm, trimerous. Accessory teeth very short. Petals small, crimson. Staminodes 3. Seeds 10-15, crimson.

This species was first identified at Kew as a form coming near *R. leptopetala* and at Central National Herbarium, Calcutta, as resembling the variety *littorea*, but in the invariable presence of staminodes and the limited number of seeds, it is more close to *R. mexicana* than to the former. However, *R. mexicana* is a miniature, prostrate plant of dull green colour and pink, tetramerous flowers. In appearance it is strikingly different from *Rotala malampuzhensis*.

Acknowledgements

For the Latin rendering of the diagnosis I am deeply indebted to Dr. Adelaide L. Stork of Stockholm University. I am grateful to Prof. K. Kesavan Nair, Victoria College, Palghat, for taking the photographs of the plant. This paper would not have come out but for the encouragement given by Dr. B.K. Nair. Professor of Botany, University of Calicut. I am also indebted to the Director, Royal Botanic Gardens, Kew for providing me with the original diagnosis for *Rotala* and helping me in identifying the plant.

Paratype specimens are deposited at the herbarium of Botanical Survey of India, Southern Circle, Coimbatore, along with type.

Observations on metamorphosing behaviour of *Cybister* larvae for development of control measures during pupal stage[1]

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(*With a text figure*)

INTRODUCTION

Several species of aquatic beetles, of the genus, *Cybister* (Family Dytiscidae) are of common occurrence in fish nurseries. Both larvae and adults are active predators, on spawn and of fishes.

Mature larvae, at the end of last instar, pupate in moist earth at the waters' edge of ponds. The easy accessability of *Cybister* beetles at the pupal stage in the vicinity of fish nurseries, makes control measures possible and studies were made on metamorphosing behaviour of the larvae, belonging to five species, namely *Cybister cognatus* Sharp, *C. limbatus* (Fabricius), *C. sugillatus* Erichson, *C. posticus* Aube and *C. tripunctatus asiaticus* Sharp. Among these, *C. tripunctatus* is the commonest and occurs in large numbers.

The term "metamorphosis" is used in a restricted sense in the text, only to denote the changes from last larval instar to the finally formed imago.

MATERIAL AND METHODS

(a) *Material*

Larvae and *Cybister* beetles were collected from fish nurseries and ponds mainly around Bombay. A stock of live material was maintained at the laboratory and were fed on minnows.

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[1] Accepted September 2, 1971.

(b) *Methods*

(i) Initially, experiments were conducted to find out the total period of pupation in the soil, once the mature larva encloses itself in the pupal cell. For this purpose, a single freshly collected larvae of a species was kept in a glass aquarium tank, measuring 30 × 23 × 23 cm. In the tank, conditions were made to conform as far as possible to natural conditions. A block of laterite soil, of approximately 22 × 15 × 15 cm size, was placed contiguously to the sidewall over a stone slab of 5 cm thickness kept on the bottom. Water level in the remaining portion of the tank was maintained at this height in order to prevent the desiccation of the clod.

Time and date of entry of the larva into the earth as well as emergence, as an adult, were recorded in order to determine the total period of pupation. The temperature of the water at the time of emergence of the adult was also simultaneously recorded.

Since there were no pupation out of freshly brought last instar *Cybister* larvae in the earth-blocks, except once, the experiments were repeated by introducing into the tank such larvae, which were fed intensively with *Gambusia* and other young fishes. These larvae became progressively dull, and stopped feeding and then readily entered the earthen-blocks. Five observations were made for each species of *Cybister* which were identified later from the imagos that emerged, namely *C. tripunctatus*, *C. cognatus*, *C. limbatus*, *C. sugillatus* and *C. posticus*.

(ii) Since the total periods of pupation varied further laboratory experiments were conducted to find out whether the total period of metamorphosis and therefore the duration of moulting into pupa and imago were constant for each species, from the date of initiation of metamorphosis by interning larvae of different species into artificial pupal cells in the earth-blocks, thereby inducing them to undergo post-larval development.

For this purpose, 20 × 15 × 12 cm size blocks, each made of laterite soil of dry weight of approximately 1500 g and 500 ml of freshwater, were prepared and kept in enamel trays. Water was poured in the tray at the base of these blocks periodically, to prevent desiccation. In each of these blocks, two crude cells of approximately 3 × 2 cm size, were prepared on either end 10 cm apart.

At a time, two larvae of a particular species which had stopped feeding, were introduced in these cells, closing them thereafter from above, with clay-tablets. Next day, the pupal cells were examined to check whether metamorphosis had been initiated by the larvae, which was indicated by the presence of a secondary earthen cap made by the metamorphosing larva under clay-tablets. This was taken as first day of metamorphosis. Subsequently, observations were made, every 24 hours, by opening the cells in one of these blocks, to examine the

progress of metamorphosis. Thus, the duration of moulting into pupa and imago were determined with reference to larvae of different species.

(iii) Larvae of *C. tripunctatus* being the most predominant in fish nurseries, laboratory experiments were conducted on these larvae, with a view to eradicating different metamorphosing stages infesting the soil above the water level, by using carbon disulphide and formaldehyde as fumigants. In all these experiments, mature larvae, showing no further response for feeding, were introduced in the artificial pupal cells, in the earthen-blocks as described above. The blocks were covered with plastic sheets after injecting the fumigants.

Preliminary experiments were conducted to find out the relationship of different quantities of a fumigant injected, and corresponding period of mortality for different metamorphosing stages, contained in the blocks.

In the experiments, four quantities of one of the fumigants, 2, 4, 6 and 8 ml were injected in four different blocks (covered thereafter with plastic sheets), each containing the metamorphosing stages of one of the five different age groups namely 3, 6, 9 and 18 day-old, at a time. At the end of 24 and 48 hours, the cells in the blocks were opened to examine the effects of increasing doses of the fumigant. These experiments showed that even 2 ml of carbon disulphide was lethal to the insects at the end of 48 hours but formaldehyde had no effect. Thus, in subsequent experiments, varying quantities of carbon disulphide had to be tried for determination of quantities of this fumigant, lethal at the end of 48 hours, for each of the advanced metamorphosing stages (1-18 days stages, and unemerged adults).

However, it was important to find out whether the progress in metamorphosis of a particular stage was arrested during the 48 hours period of fumigation. For this purpose, the blocks (covered with plastic sheets after injection) containing 8 and 17 day-old stages were injected with the quantities of carbon disulphide, lethal at the end of 48 hours. At the end of 24 hours and 48 hours, the cells were opened and 8th and 17th day stages were examined to see whether these had moulted into pupa and adults, respectively, (i.e. 9th and 18th day stages).

Similarly, experiments conducted to find out whether the arresting effect can also be brought about by the disturbance caused by the opening and closing of the cells containing 8th and 17th day stages, showed that moulting did not take place at the end of even 48 hours. Thus, these experiments have shown that in both cases, arresting of metamorphosis took place.

With these preliminary but important observations, experiments were continued by injecting varying quantities of carbon disulphide in the centre of the 20 × 15 × 12 cm size blocks, each with two artificial cells, 10 cm apart, each containing one metamorphosing stage at a

time (i.e. one of the 1-18 day old stages + unemerged adults), with a view to determining the lethal quantities at the end of 48 hours for different stages. Before injecting the fumigant, both cells were opened to ascertain whether the metamorphosing stages in the blocks were in normal state of development. This also served as a coordinate arresting factor of metamorphosis during the period of 48 hours of fumigation.

(iv) Experiments were also conducted with a view to determining the comparative toxicity of two more fumigants, namely ethylene dibromide and ethylene dichloride along with carbon disulphide. For this purpose, a distinct stage common for all the five species, i.e. tenerials of *C. tripunctatus, C. limbatus, C. cognatus, C. sugillatus* and *C. posticus,* were selected as experimental material. At a time, different quantities of one of the fumigants were injected into the blocks, forming five sets. Each block in a set contained two tenerials of one species. Thus, the quantity of each of the three fumigants, lethal at the end of 48 hours for different species, was determined.

Observations

i) *Total pupation period*

The experiments have shown that only larvae, which had stopped feeding readily burrowed into the earth-blocks for metamorphosis after a day of exploration. The total period of confinement in the case of *C. tripunctatus* varied between 19-34 days, and in *C. cognatus* and *C. limbatus,* the period varied between 28 to 32 days. With other two species, *C. sugillatus* and *C. posticus,* the period ranged from 25-32 days. In no case did the larvae penetrate the soil beyond 7-8 cm. Water temperature at the time of emergence of the adults varied from 29-30°C.

ii) *Total period of metamorphosis and the duration of pupal and imago stages in different* **Cybister** *larvae*

The artificially introduced larvae started reshaping the interior of the artificial cells by making the inner facet smooth, and then lay coiled at the bottom, at the end of 24 hours' activity. This behaviour was indicative of their undergoing normal metamorphosis, outwardly manifested by the presence of a secondary cap underneath the clay-tablet, placed over the opening of the artificial cell, immediately after confinement.

Observations at one day intervals subsequently have shown that in the case of *C. tripunctatus* pupa was formed on the 9th day, and the adult on 18th day. In *C. sugillatus* and *C. posticus,* pupa was seen on 12th day and the imago on 24th day. With both *C. cognatus* and

C. limbatus, the pupation took place on 15th day and the moulting into imago on 27th day. In all these cases, the newly formed adults remained in pupal cells for varying number of days before emergence. The larval skin after pupation is stuck into the inner wall of the pupal cell, whereas the pupal exuvium is seen underneath the imago in all the species.

iii) *The lethality of carbon disulphide, at the end of* 48 *hours for different metamorphosing stages of* **C. tripunctatus** (Table 1) (Fig. 1).

Preliminary experiments, to find out whether there was any inverse relationship between increasing doses of the fumigant and decreasing survival periods, showed that at the end of 24 hours of fumigant action there was no mortality with 2, 4, 6 and 8 ml of the fumigant, whereas at the end of 48 hours, mortality occurred invariably with each of these quantities of the fumigant for different metamorphosing stages comprising 3, 6, 9, 12, 15 and 18 day stages showing that this period was necessary for fumigant diffusion. Similar experiments with formaldehyde, another common fumigant, have shown that there was no lethal effect during the entire period of observation.

In experiments with 8th and 17th day stages, contained in the pupal cells, the quantities of carbon disulphide (0.75 and 2.0 m) determined previously as lethal at the end of 48 hours, were injected. At the end of this period, that is on the 10th and 19th days, the dead insects were examined, and it was observed that these had not moulted respectively into pupa and imago, showing that metamorphosis was arrested during the entire period of fumigation.

TABLE 1

QUANTITIES OF CARBON DISULPHIDE LETHAL AT THE END OF 48 HOURS FOR DIFFERENT STAGES DURING METAMORPHOSIS IN CASE OF *Cybister tripunctatus.*

Age in days of metamorphosis-stage	Quantity of the fumigant in ml	Age in days of metamorphosis-stage	Quantity of the fumigant in ml
1	2.0	11	0.75
2	2.0	12	1.0
3	2.0	13	1.0
4	2.0	14	1.0
5	1.5	15	1.5
6	1.0	16	2.0
7	1.0	17	2.0
8	0.75	18	1.0
9	0.5	19 to 35	1.0
10	0.5	Unemerged adults	1.0
		Emerged adult	

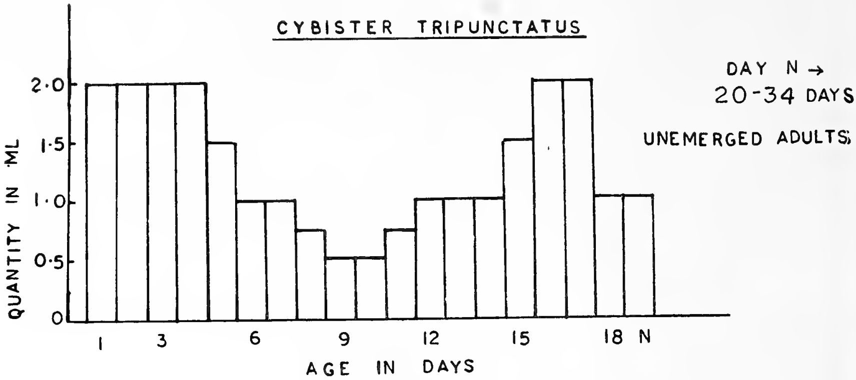

Fig. 1. A graph showing comparative lethal effect of 2 ml of carbon disulphide on various metamorphic stages of *Cybister tripunctatus.*

The other factor, responsible for arresting normal metamorphosis, was the opening and quick closing of the cell-tops. The 8th and 17th day prepupal and preimaginal stages failed to moult respectively into pupa and imago even at the end of 48 hours, showing that such a disturbance retarded the normal pace of metamorphosis.

TABLE 2

COMPARATIVE TOXICITY OF THREE FUMIGANTS IN CASE OF TENERIALS OF FIVE *Cybister* SPECIES, (AT THE END OF 48 HOURS OF FUMIGANT ACTION)

Cybister species	Fumigants	Quantity in ml
1. *Cybister tripunctatus*	Carbon disulphide	1.0
	Ethylene dichloride	0.75
	Ethylene dibromide	0.5
2. *C. cognatus*	Carbon disulphide	0.5
and	Ethylene dichloride	0.75
3. *C. limbatus*	Ethylene dibromide	0.5
4. *C. sugillatus*	Carbon disulphide	0.5
and	Ethylene dichloride	0.75
5. *C. posticus*	Ethylene dibromide	0.5

Experiments were conducted, based on preliminary observations, to determine the quantities of carbon disulphide lethal at the end of 48 hours for different stages contained in 20 × 15 × 12 cm size blocks (covered with polythene sheets after fumigant injections). The results are given in Table 1. It can be seen from this Table that 9th and 10th day stages requiring a lethal quantity of only 0.5 ml of the fumigant are the least tolerant and 1-4th and 16-17th day stages requiring 2 ml

of carbon disulphide are the most tolerant. Similar experiments on adults (emerged), confined in the artificial pupal cells in the blocks, have shown that even 1 ml of the fumigant was lethal at the end of 48 hours. These results are illustrated in fig. 1.

iv) *Comparative toxicity of the three fumigants on unemerged imagines of different* **Cybister** *species* (Table 2).

From table 2, it can be seen that the quantities of carbon disulphide, ethylene dichloride and ethylene dibromide lethal for different species were 0.5-1.0, 0.75 and 0.5 ml, respectively, showing that ethylene dibromide is the most toxic and ethylene dichloride, the least, except in case of *C. tripunctatus.*

Discussion and conclusions

Studies on metamorphosing behaviour of different last instar *Cybister* larvae, were made by conducting a series of laboratory experiments, so that a suitable method for their eradication from infested moist soil above water level in fish nurseries could be devised.

Initial experiments were conducted for determining the total periods of confinement in the earth above the water level, after the mature larva constructed a pupal cell for undergoing post-larval development. These experiments were of considerable significance, as different *Cybister* larvae, which could not be identified to their respective species in immature condition could be identified as belonging to five different species from their adults. Amongst the five species of larvae, *Cybister tripunctatus* resembles the larvae of *C. cognatus* and *C. limbatus* except for its size, measuring on an average about 5 cm in length, whereas the larvae of the latter two species are the largest of all the *Cybister* larvae measuring about 7-8 cm in length. Both *C. cognatus* and *C. limbatus* larvae resemble each other except that *C. cognatus* is slightly smaller, and possesses conspicuous longitudinal stripes on the dorsal side. Their adults also appear almost identical except for minor differences in abdominal colour. Larvae of *C. sugillatus* and *C. posticus* also resemble each other, measuring 4.5 cm in length on an average. The larva of *C. posticus* is slightly larger than *C. sugillatus* and possess conspicuous stripes on its dorsal side. The larvae of both species can, however, be distinguished from other *Cybister* larvae, by their distinct black and sclerotized head.

The total period of confinement determined, from the time of last instar larval internment to that of emergence as an adult, varied considerably in case of *C. tripunctatus,* being in the range of 19-43 days, whereas with both *C. cognatus* and *C. limbatus,* the variation was in

the narrow range of only 28-32 days. At the time of emergence of the adults the water temperature was seen to be around 29-30°C.

Considering that the total period of confinement in the earth above the water level are variable, in different *Cybister* larvae, further series of experiments were started to ascertain whether the duration of moulting into pupa and adults were also variable. For this purpose, a technique of inducing the mature larvae to undergo metamorphosis in the artificial cells (with similar dimensions of natural cell, i.e. 2 × 3 cm), prepared in 20 × 15 × 12 cm size earthen blocks, was developed, thus facilitating greatly, further series of experiments. During the metamorphosis period, observations at 24 hour intervals have revealed that *C. tripunctatus* had the shortest period for metamorphosis, the pupa and adult being formed on 9th and 18th day, respectively, whereas with the other two *C. cognatus* and *C. limbatus,* the period was 15 and 27 days respectively. During experimental period water temperature varied around 29-30°C.

These results show that although total period of metamorphosis was constant for each species, the period of confinement of the adult (tenerials), were variable as indicated by the previous series of experiments. Thus, the adult of *C. tripunctatus* remains unemerged for varying periods up to 15 days as against other species which remain quiscent for varying periods up to 8 days.

From the number of days required for the emergence after imago formation, it can be seen that after the pupa moults into adult, it remains in confinement for a minimum period of about 24 hours. Further confinement for varying periods prior to emergence may be dependent upon factors such as temperature.

These observations on metamorphosing behaviour of different mature *Cybister* larvae, thus formed the basis for undertaking further studies on their eradication. For this purpose, *C. tripunctatus* was chosen, as it occurred in large numbers in fish nurseries.

Formaldehyde and carbon disulphide, were selected as fumigants. Formaldehyde is commonly used as soil fumigant in agriculture to control root pests. Similarly, carbon disulphide is a well-known fumigant, used for the purpose since 1925 (Fleming 1926, Gough 1945).

Preliminary experiments have shown that; (1) a period of 48 hours was required for lethal action of different doses of carbon disulphide, possibly due to time taken for initial diffusion of the fumigant vapour through the substance of the block, before concentrating in the cavities of the pupal cells, till mortality occurred; (2) Even 6-8 ml of formaldehyde was not lethal at the end of 48 hours, thus ruling out its use for application in the field and; (3) during the experimental period of 48 hours of fumigation, different stages remained unadvanced in metamorphosis due to two factors, the disturbance caused by opening and

rapid closure of the cell and sublethal concentration of the fumigant vapour in the cell.

With these points in view, different quantities of carbon disulphide were injected in the centre of the blocks (covered subsequently with polythene sheets), containing different metamorphosing stages from 1-8 days and unemerged as well as emerged adults.

These experiments revealed that the quantities of carbon disulphide lethal at the end of 48 hours for different metamorphosing stages, were variable. The 8th and 9th day stages were the least tolerant, even 0.5 ml of the fumigant being lethal, whereas 1-4th and 16-17th day stages were the most tolerant requiring not less than 2 ml of carbon disulphide. The remaining stages required 0.75, 1.0 or 1.5 ml of this fumigant depending upon their capacity of resistance. However, in case of majority of the stages, comprising unemerged as well as emerged adults, 1.0 ml of the fumigant was quite lethal.

The common lethal quantity for all the metamorphosing stages, was 2 ml of carbon disulphide per 20 × 15 × 12 cm size block of laterite soil, containing any of the stages, for bringing about mortality at the end of 48 hours.

A final series of experiments on comparative toxicity of the three fumigants on common stages in metamorphosis, i.e. tenerials of five *Cybister* species, showed that 0.5 ml of ethylene dibromide as well as carbon disulphide were lethal at the end of 48 hours, for all the species except *C. tripunctatus,* which required at least 1 ml of carbon disulphide, whereas for ethylene dichloride, the lethal quantity at the end of 48 hours was 0.75 ml. This indicated that ethylene dibromide is the most toxic and ethylene dichloride, the least.

The use of ethylene dibromide would not only be more effective but also economically feasible. This fumigant again unlike carbon disulphide, has no obnoxious odour and is not inflammable. This chemical has been in use as a soil fumigant in agriculture since 1945 (Shepard 1951).

For application in the field the following recommendation can be made. In fish nurseries the soil above the water line may be marked into units, each corresponding to 20 × 15 × 12 cm size block. Then 2 ml of the fumigant can be conveniently injected in the centre of each of these units (at a depth of nearly 7 cm) with subsequent coverage of the whole strip of 15 cm wide, infested with metamorphosing stages, with plastic sheet or gunny cloth, which can be fastened to the surface of the soil by applying nails along both the edges. Since metamorphosis from last instar larva onwards, in case of *C. tripunctatus* extends upto 18 days with a few additional days for unemerged adults, further fumigation can be done at intervals of about 18 days. In fish nurseries, the whole period of spawn to fry stage would not take more than 18

days even if two crop rotations are taken. Hence, an initial application of the fumigant, prior to stocking of the spawn and a second after about 18 days would be sufficient to check the menace of emerging adults of *C. tripunctatus* in fish nurseries.

Acknowledgements

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Pseudobrassaiopsis - A new genus of Araliaceae with a note on the status of *Euaraliopsis* Hutch.[1]

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J. Hutchinson (1967) treated a group of Araliaceaeous plants with leaves digitately lobed or fid formerly included under *Brassiopsis* Dcne. & Planch. *sensu lato* as belonging to a distinct genus. He named his new genus as *Euaraliopsis* quite aware of the name given by Kurz (1870). Kurz had not furnished a description of the genus and Hutchinson described it in English. In accordance with Art. 36 of ICBN (1966) a latin diagnosis with points of alliance is to be supplied to validate the genus *Euaraliopsis* Hutch. It is, however, noted that Hutchinson rejected the name *Araliopsis* of Kurz and gave the genus a new name *Euaraliopsis* which means allied to *Araliopsis.* But as no legitimate genus of that name exists, naming of the new genus as *Euaraliopsis* is also not appropriate.

I therefore proposed another name for this genus as *Pseudobrassaiopsis* to indicate its close relationship with *Brassaiopsis* Dcne. & Planch. A latin diagnosis is given below:

Pseudobrassaiopsis gen. nov.
Araliopsis Kurz, Andaman Rep. App. 39. 1870 *nom. nud.*
Euaraliopsis Hutch. Gen. Fl. Pls. 2:80. 1967; Balak. in J. Bombay nat. Hist. Soc. 67(1):60. 1970 *nom. illeg., nom. rej. prop.*

Affine generi *Brassaiopsi,* a quo differt foliis digitatim dissectis vel lobatis.

Arbores, frutices vel plante volubiles; rami et petiole saepe valde aculeati; folia digitatim dissecta vel lobata, raro tantum dentata; indumentum interdum stellatum; stipulae nonnunquam durae et persistentes; umbellae paniculatae; bractae parvae vel nullae; flores saepe polygami; calyx ad marginem 5-dentatus; petala 5, valvata; stamina 5, ovarium biloculare; fructus subglobosi vel obovoidei.

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[1] Accepted April 13, 1973.

Type: *Pseudobrassaiopsis polyacantha* (Wall.) R. N. Ban. comb. *nov.*

DISTRIBUTION: India, Nepal, Bhutan, Sikkim, Malay Peninsula, Indo-China and China.

1. **Pseudobrassaiopsis hainla** (Buch. Ham. ex D. Don) R. N. Ban. comb. nov.
   Hedera hainla Buch. Ham. ex D. Don Prodr. 187. 1825.
   Euaraliopsis hainla (Buch. Ham. ex D. Don) Hutch. Gen. Fl. Pls. 2:624. 1967.
   Brassaiopsis hainla (Buch. Ham. ex D. Don) Seem. in J. Bot. 2: 291. 1864, Revis. Heder. 18. 1868, pro. parte;
   Clarke in Hook. f. Fl. Brit. India 2:735. 1879; Harms in Nat. Pflanzen fam. 3(8) 43. 1894.
   Panax hainla (D. Don) DC. Prodr. 4:203. 1830.
   Panax crucifolia Griff. Itin. Notes 2:145. 1848.
   DISTRIBUTION: India, Nepal and China.

2. **Pseudobrassaiopsis hispida** (Seem.) R. N. Ban. *comb. nov.*
   Brassaiopsis hispida seem. l. c. 292; Clarke in Hook. f. l. c. 736.
   DISTRIBUTION: India, Sikkim, Bhutan and China.

3. **Pseudobrassaiopsis alpina** (Clarke) R. N. Ban. *comb. nov.*
   Brassaiopsis alpina Clarke in l. c. 736.
   Euaraliopsis alpina (Clarke) Balak. l. c. 60.
   DISTRIBUTION: India and Sikkim.

4. **Pseudobrassaiopsis polyacantha** (Wall.) R. N. Ban. *comb. nov.*
   Hedera polyacantha Wall. Pl. As. Rar. 2:82. t. 190. 1831.
   Panax palmatum Roxb. Hort. Beng. 21. 1814, nom. nud., Fl. Ind. 2:74. 1832.
   Brassaiopsis palmata (Roxb.) Kurz in J. Asiat. Soc. Bengal 39(2): 77. 1870; Clarke l. c. 735; Harms l. c. 43.
   Brassaiopsis polyacantha (Wall.) Ban. in. Ind. For. 93(5):341. 1967 Syn. nov.
   DISTRIBUTION: India, Burma, Nepal, China and Malay Peninsula.

5. **Pseudobrassaiopsis andamanica** (R. N. Ban.) R. N. Ban. *comb. nov.*
   Brassaiopsis andamanica R. N. Ban. in. Ind. For. 94(10):775. 1968. Syn. nov.
   DISTRIBUTION: India, Nepal, Burma, China and Malay Peninsula.

6. **Pseudobrassaiopsis griffithii** (Clarke) R. N. Ban. *comb. nov.*
   Brassaiopsis griffithii Clarke l. c. 736.; Harms l. c. 43.
   Euaraliopsis griffithii (Clarke) Balak. l. c. 60.
   DISTRIBUTION: India and Burma.

7. **Pseudobrassaiopsis mitis** (Clarke) R. N. Ban. *comb. nov.*
Brassaiopsis mitis Clarke, 1. c. 736.
Euaraliopsis mitis (Clarke), Balak. 1. c. 60.
DISTRIBUTION: India, Indo-China and China.

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Belly-soaking in the Charadriiformes[1]

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Belly-soaking consists in wetting the belly feathers for the purpose of transporting water to eggs or chicks. It occurs regularly in the sandgrouse for watering the chicks. It occurs also in the Charadriiformes among the families Charadriidae, Glareolidae, Recurvirostridae, Laridae, Sternidae and Rynchopidae. Its main function appears to be for cooling the eggs or young; whether the young also drink the water provided by the parents in this way has not been proven. Belly-soaking appears to be absent from all other orders of birds. Its presence may be further evidence for placing the sandgrouse (Pteroclididae) in the order Charadriiformes, as suggested by Gatter (1971). The origins of belly-soaking are discussed.

Introduction

Ever since I began field studies on the sandgrouse (Pteroclididae) (Maclean 1968), I have been interested in water transport by birds in their belly feathers (*see* Cade & Maclean 1967). In view of my conclusions that the sandgrouse are actually Charadriiformes, or at least very closely related to them (Maclean 1967), it is interesting, if not significant, that the only taxon of birds other than the Pteroclididae in which belly-soaking occurs regularly is the Charadriiformes. The suggestion that *Ixobrychus exilis* in the United States also transports water in its belly feathers rests on a misinterpretation of the single observation by Weller (1961) of a male Least Bittern which waded into water about a metre deep on a very hot day, in an apparent attempt to cool itself before returning to its young. This behaviour does not seem to have constituted belly-soaking in the present sense. "Belly-soaking" refers here to deliberate wetting of the ventral plumage for the purpose of water transport to eggs or young. The term excludes incidental wetting of the ventral plumage in aquatic birds, or in species which do not use the water for watering eggs or young.

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Occurrence of Belly-soaking

Belly-soaking has been observed in six families of the order Charadriiformes, excluding the Pteroclididae, namely: Charadriidae, Glareolidae, Recurvirostridae, Laridae, Sternidae and Rynchopidae. The first three families belong to the suborder Charadrii, the last three to the suborder Lari. For convenience I shall deal with the published information by families.

1. **Charadriidae**

(a) *Charadrius*

Only two species of *Charadrius* have been shown to soak their bellies. Dharmakumarsinhji (1964) writes that *C. alexandrinus* near Bhavanagar in Gujarat has a frequent changeover at the nest during the hot hours of the day, and that the relieving bird "would often have its breast wet to keep the eggs moist". Hobbs (1972) suggests that the same species in southeastern Australia may do the same thing, but his evidence is indirect, based on the muddy coating of eggs which, however, may be attributed to nesting on a damp substrate.

The most remarkable account of belly-soaking outside of the sandgrouse family is that of Gatter (1971) in *C. dubius*. He observed a breeding population near Plochingen on the Neckar in West Germany. Between 1200 and 1400 hours on what he considered to be a hot day (29.2°C in the shade), both parents at a nest with newly hatched chicks took it in turns to run to a nearby pool, soak their belly feathers by running quickly through the water, and then run or fly back to the young, which they brooded with their wet plumage, ostensibly to keep them cool.

Pitman (1965) indicates that *C. pecuarius* in Zambia "seemed.... to have wet breasts" when coming to relieve the mate at the nest in very hot weather.

(b) *Vanellus*

Five species of *Vanellus* have been observed soaking their belly plumage for the purpose of wetting their eggs or young. During a single period of observation on the Benue River in Nigeria, Serle (1939) watched *V. albiceps* make about 12 trips from its nest to the river where it dipped its breast and belly several times in the water, then dipped its bill, and finally walked back to its egg. This took place at 1300 hours in the heat of the day. Bainbridge (1965) recorded similar behaviour in this species on the Zambezi River, but only when the sun was shining and air temperatures were over 32°C in the shade; eggs were not wetted on a cloudy day when the air temperature was less than 32°C.

At two nests of *V. spinosus* in Egypt, during hot July weather, Crossley (1964) saw the adults go several times to the water to wet the belly feathers immediately before returning to the nest; Dharmakum-

arsinhji (1964) recorded identical behaviour in *V. indicus* at Bhavnagar. Jayakar & Spurway (1965a, b) noted the same thing in *V. malabaricus* between 1114 and 1605 hours at one nest where the male parent wetted the eggs twice and the female eight times; the source of water was a wet concrete pavement under a dripping tap. The birds would soak their feathers for up to 10 min at a time before returning to relieve the mate at the nest. Red lateritic mud was conspicuous on both the eggs and the parents' belly feathers. This behaviour was seen only in April, the hot season, and even occurred after all four chicks of the brood had hatched.

Wright (1963) recorded wetting of eggs and young in *V. senegallus* in Zambia. The parent soaked its abdominal feathers in a water-filled hippo track and then settled onto the eggs and chicks. When the parents left the chicks for 10 or 15 min, the chicks died of heat exposure.

Dresser (1902) writes of *V. leucurus* in the breeding season: "During the hottest part of the day it either rests on the shores of the lakes or in water which reaches up to its bellly." This may be no more than a suggestive coincidence, but Dresser does not mention that birds that have been resting thus in water have then gone to a nest with eggs.

2. Glareolidae

(a) *Pluvianus*

In a footnote to a short communication by Abdulali (1939), to certain terns, using their belly feathers as the transport mechanism, the Editors of *J. Bombay nat. Hist. Soc.* state that "the Egyptian Plover (*Pluvianus aegyptius*) is said to moisten its eggs in a similar manner". They give no reference to their source of information. However, Butler (1931) mentions that this species regurgitates water onto the sand under which the eggs are buried.

(b) *Glareola*

Dharmakumarsinhji (1964) says that the parents at a nest of *Glareola lactea* changed over on the eggs about every 25 to 35 min during the hot hours of the day, and that the incoming bird would often have its breast wet. A similar, but rather inconclusive statement has been made about *G. pratincola* at a breeding colony in Zambia (Pitman 1965).

3. Recurvirostridae

Dharmakumarsinhji (1964), again observing in Gujarat, writes that changeover between the parents at a nest of *Himantopus himantopus* was frequent in the heat of the day, and that both parents would wet their belly feathers before returning to the nest, "by bobbing down to the water while wading."

4. **Laridae**

The only account of belly-soaking in the gulls is that of Meinertzhagen (1954), who mentioned that parents in a colony of *Larus genei* on Bahrain Island have been seen sprinkling their eggs with sea water during the heat of the day.

5. **Sternidae**

Three observers have independently recorded belly-soaking in *Sterna albifrons* for the purpose of taking water back to the eggs (Abdulali 1939; Dharmakumarsinhji 1964; Tompkins 1942). The plumage was wetted either in flight or when wading into the water. Abdulali (1939) recorded a changeover of the parents every minute or so throughout an hour's observation period on Salsette Island off the west coast of India.

Currie (1916) found the eggs of *Sterna acuticauda* near Lahore "besprinkled all over with water." In more general terms, Lowther (1949), who photographed extensively on the Jumna River in northern India, wrote that "the parent terns and skimmers do overtime splashing water over their eggs and young" during sandstorms in the heat of summer.

6. **Rynchopidae**

Ali & Ripley (1969b) state specifically of *Rynchops albicollis* that the parents soak their ventral plumage and splash water over the eggs and young to keep them cool.

Functions of Belly-soaking

The one environmental factor associated with belly-soaking and subsequent wetting of eggs or chicks in the Charadriiformes in all accounts that I have read has been intense heat, but only Ali & Ripley (1969b), Crossley (1964), Gatter (1971) and Tompkins (1942) suggest that the function of this behaviour is to cool the eggs or young. Tompkins (1942) adds that wetting may serve also to replace moisture lost from the egg by evaporation.

The latitudes and approximate climatic conditions of the main study areas mentioned in the literature are shown in Table 1. The driest region is around Bhavnagar in Gujarat, India, but even this has a mean annual rainfall of over 500 mm. All the other regions in Table 1 are wetter than this and some, like Georgia, U.S.A., are very wet indeed. Evaporation therefore seems to constitute a smaller hazard to the eggs and young of birds than overheating. The lethal effects of overheating on plover chicks has been shown clearly by Wright (1963). The best

direct evidence is probably that of Bainbridge (1965). The main function of belly-soaking in ground nesting birds would thus appear to be cooling.

TABLE 1

PLACES IN WHICH BELLY-SOAKING HAS BEEN OBSERVED IN THE CHARADRIIFORMES, SHOWING LATITUDES AND APPROXIMATE CLIMATES

Locality	Latitude	Mean midsummer temperature °C	Mean annual rainfall cm
Plochingen, West Germany	49°N	18-22° (warm)	75-100
Benue River, Nigeria	9°N	22-27° (hot)	100-200
Georgia, U.S.A.	30-35°N	27° (v. hot)	200-300
Bhubaneswar, India	20°N	27° (v. hot)	100-200
Jumna River, India	26°N	27° (v. hot)	100-200
Bhavnagar, India	22°N	27° (v. hot)	50-100
Kafue National Park, Zambia	15-16°S	22-27° (hot)	100-150
Victoria Falls, Zambia	18°S	22-27° (hot)	75-100

This conclusion is partly confirmed by the fact that sea water as well as fresh water is used for egg-wetting. Apart from the fact that the egg shell and membranes are only slightly permeable to water, so that evaporation from within and penetration of water from outside are very slow, the osmotic differences between the egg albumen [freezing point about –0.45°C (Romanoff & Romanoff 1967)] and sea water (freezing point about –2°C) are such that water would tend to pass out of the egg rather than into it when sea water was applied to the shell. Further confirmation is the fact that *Charadrius dubius* seems to wet its chicks in the same way as other charadriiforms wet their eggs under the stress of high ambient temperatures, although of only about 29°C, which in other parts of the world in which belly-soaking has been recorded would not constitute a hot day. Air temperature of only 29°C accompanied by high relative humidity would certainly not result in a dangerously high rate of evaporation from a bird's egg (*cf.* Romanoff & Romanoff 1949:380).

Tompkins (1942) implies that skimmers, oystercatchers, plovers and nightjars "using a similar nesting ground" to *Sterna albifrons* in Georgia do not need to counteract evaporation from their eggs by wetting them as the terns do, because their eggs have much thicker shells. I do not believe that actual measurements would substantiate this claim—certainly it is hard to believe that a nightjar could lay a thicker-shelled egg than a tern. In any case skimmers and plovers in other

parts of the world have indeed been seen wetting their eggs (Dharmakumarsinhji 1964; Lowther 1949).

Discussion

Nearly all the species of birds that regularly transport water in their belly feathers nest near water, or fly daily to water to drink. They thus have contact with water at least once daily even if, like the sandgrouse, they are not primarily birds of waterside habitats. The main exception to this rule is *Vanellus malabaricus* which is not a waterside breeder as a rule (Ali & Ripley 1969a), but is sufficiently adaptable to capitalize on the water from a dripping tap when it is available. What does *V. malabaricus* do for water in the absence of any artificial supply in a habitat such as a fallow field?

An even more interesting question is: How have those species of charadriiforms that nest in hot regions in the complete absence of water become adapted at the egg stage to high temperatures without the need for water-cooling? I am thinking here especially of the coursers; but the same question could apply to any desert bird, even the sandgrouse which, as far as I know, do not moisten their eggs during incubation.

The answer cannot lie simply in the thickness of the egg shell as suggested by Tompkins (1942), since even such small ground-nesting birds as larks survive adequately without the need to wet their eggs in any way. It may, however, lie in a reduced permeability of the egg shell and egg membranes to water loss (and therefore probably to water uptake—hence the absence of egg-wetting), or more likely to an increased resistance of the embryo to high temperatures. Accurate measurements of embryonic tolerance to high temperatures are needed to show what differences exist among the charadriiforms, if any. It is also necessary to know at what ambient air temperature belly-soaking is initiated, and how this temperature correlates with embryonic temperature tolerance.

Another possible factor is the thermoregulatory ability of the adults at high temperatures. Desert forms may be more efficient at keeping their own body temperatures lower than non-desert forms, for example.

The possibility of egg-wetting serving to counteract the effects of water lost by evaporation cannot be ruled out as a cofactor; here again quantitative data are essential.

A check of the breeding seasons and distributions of charadriiforms in which belly-soaking has been recorded shows that they are mostly spring to summer breeders in the northern hemisphere (see also Table 1), so that they have eggs or young when air temperatures are high, especially in India where the habit is most widespread. Most southern Afri-

can charadriiforms nest from about midwinter (July) to late spring when air temperatures are relatively low. Although the charadriiforms of south America are mainly spring and summer nesters, the climate is generally mild. These facts may account for the apparent absence of belly-soaking in these southern hemisphere forms, and support further the idea that its function is primarily one of cooling. But belly-soaking has not been established in Australian charadriiforms, many of which nest in summer.[1]

One might also expect equatorial charadriiforms of both hemispheres to practise belly-soaking. It has been suggested for *Pluvianus aegyptius* (Butler 1931), and has been recorded in *Vanellus albiceps* at 9°N (Serle 1939) and at 18°S (Bainbridge 1965), and in *V. senegallus* at about 15°S (Wright 1963), but surprisingly has not been seen in these species elsewhere in their range, nor in any other species of charadriiforms in Africa or tropical America as far as I know. This may reflect a scarcity of observers in these regions, rather than an absence of the behaviour pattern, so that it should be carefully looked for in future.

What about the origin of belly-soaking? Since it is a transport mechanism whose function seems to be mainly one of cooling, the suggestion of Tompkins (1942) that "the origin of the practice may be merely the wish of the bird to cool herself" is probably correct. The incidental wetting of the ventral plumage in *Ixobrychus exilis* while the parent bird was wading in deep water to cool itself on a hot day (Weller 1961) seems to offer some small confirmation of the idea.

An alternative suggestion is that belly-soaking might have been derived from bathing behaviour (Cade & Maclean 1967). This idea and the previous idea are not mutually exclusive, except that, in my experience in southern Africa, birds bathe more frequently in cold weather than in hot. However, I have seen a type of "bathing" in both *Charadrius tricollaris* and *Vanellus armatus* that resembled exactly the belly-soaking movements of sandgrouse, involving wetting the belly plumage only, without any of the head and wing movements typical of other birds. These plovers were doing this on cold days in July and April respectively. Was this belly-soaking or bathing? If the former, what was its purpose? On neither occasion did the bird go to a nest following the behaviour. If it was bathing, it was manifested in only the most rudimentary form. The matter is clearly in need of closer attention.

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[1] In December 1974 I saw a *Charadrius melanops* in New South Wales soak its belly feathers before flying to the nest to relieve its mate.

(Note added in proof)

ZUSAMMENFASSUNG

Wasseraufnahme im Bauchgefieder zum Zweck des Wassertransports, eine Funktion, die ich "Belly-soaking" genannt habe, kommt nur unter den Flughühnern nud den Charadriiformes vor. Diese Wasserspeicherung unter den Charadriiformes dient hauptsächlich zur Kühlung der Eier oder Küken. Ob die Jungen auf dieser Weise auch getränkt werden, ist noch nicht festgestellt worden. Wassertransport im Bauchgefieder fehlt scheinbar in allen anderen Vogelordnungen; sein Vorkommen scheint ein weiterer Verwandtschaftsbeweis zwischen den Pteroclididae und den Charadriiformes zu bilden, wie schon von Gatter (1971) vorgeschlagen ist. Das Entstehen dieses eigenartigen Verhalten wird diskutiert.

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Observations on the occurrence and habits of juvenile fishes in the nearshore region of the Mandapam area[1 & 2]

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During 1952-55, I made a study of the juvenile fishes and their habits in the nearshore region in the Mandapam area. The study, confined mainly to the Palk Bay was facilitated largely because of the existence of a fishery exclusively for juvenile fishes, although data from other sources were also available. The present account deals with juveniles observed in the region up to about 2 km from shore during the period referred to above.

Studies were undertaken in the Palk Bay along a 5 km stretch of the coast between Munakkad and Pullamadam, and in the Gulf of Mannar at a point opposite the jetty of the Central Marine Fisheries Research Institute. Three sources of data were available for this account: (i) The commercial fishery, (ii) Experimental light fishing conducted by the C.M.F.R. Institute, and (iii) Independent observations undertaken by me during weekly sea trips at night.

(i) *The commercial fishery*: Juveniles are landed mainly by torch and hand-net boats (operated at night) and shore-seines (Sekharan 1955), the catches being greater during the new moon periods than during other periods. Another net operated is *Ola Valai*, a small shore-seine with the dragging ropes on either side having long dry palmyrah leaves attached to them. Observations on the fishery were conducted along the Palk Bay coast.

(ii) *Experimental light fishing*: Chellappa (1959) has described the experimental light fishing conducted in the Gulf of Mannar at Mandapam. On a number of occasions I also made observations on the fishes caught by this method.

(iii) *Independent personal observations*: During weekly sea trips at night, observations were made of fishes attracted by the light from

[1] Published with the permission of the Director, C.M.F.R. Institute, Cochin-18.
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a 2-cell electric torch and also of fishes in the near-shore region.

Data on the important species represented in the catches are based exclusively on the samples collected from the landings of torch-and-hand-net boats and shore-seines. Samples were taken, usually once a week, at night and preserved in formalin. In the laboratory, they were sorted into species, and the total length measured. The methods adopted for estimating the landed weight and number of the two important species of *Sardinella* which comprised the bulk of the landed catch of young fishes have been described elsewhere (Sekharan 1971).

The juveniles described here measure generally less than 70 mm. In terms of numbers and weights of all species combined, their period of peak occurrence in the Palk Bay is March-June, and only that period is referred to here in respect of the Palk Bay. In respect of the Gulf of Mannar the period referred to is January-April.

About 60 species of young fishes have been identified in the near-shore region, all common to the fish fauna of both the Palk Bay and the Gulf of Mannar. The more common species and their length ranges are given in the table.

Observations on the shoals of juveniles

Shoals of young fishes which consisted mostly of *Sardinella* spp. and *Stolephorus* spp., and which are easily recognised as luminescent patches, were either stationary or showed random movement. The noise or vibration caused by the outboard engine (10 HP) used did not seem to scare the fish, inasmuch as no sudden movement could be noted when I collected plankton samples either directly over the shoals or very close to them.

On a few occasions, I was able to watch the sardine shoals in different stages of encirclement by the shore-shine. The shoals touching the wide-meshed part of the wing (made of coir rope) do not show any tendency to escape; instead individual fishes could be seen darting to and fro, seeming to peck at the net and then withdrawing, when the area enclosed by the net is very wide. On the other hand, when the enclosed area becomes smaller and smaller, the fish begin to escape from the net, and could easily be collected with a cloth (Sekharan 1959). In other words, the tendency to escape seems caused not so much by a slight obstruction in the path of the shoal, but by the limitation of the area of movement. A similar reaction has been inferred from studies of demersal fishes (Manteufel & Radakov 1964).

During March-June, the sardines are less than 65 mm on the average and are not normally found at the surface during day-time

TABLE

Gear	Species	Length-range (mm)
Torch-and hand-net. (Palk Bay)	*Sardinella albella* (Val.)	18—70
	Sardinella gibbosa (Bleeker)	18—70
	Other *Sardinella* species	20—70
	Hilsa kelee (Cuvier)	25—65
	Stolephorus indica (Van Hasselt)	15—60
	Stolephorus spp.	10—65
	Gerres filamentosus Cuv. & Val.	25—60
	Gerres spp.	30—70
	Leiognathus splendens (Cuv.)	10—70
	Leiognathus spp.	8—60
	Atherina spp.	30—70
Shore-seine (Palk Bay & Gulf of Mannar)	The species mentioned above, plus	
	Ilisha spp.	50—75
	Escualosa thoracata (Val.)	40—60
	Thrissocles spp.	30—70
	Selaroides leptolepis (Cuv. & Val.)	20—60
	Other *Caranx* spp.	25—65
	Hemirhamphus spp.	60—80 (from lower jaw)
	Cypselurus sp.	65—80
	Platycephalus spp.	50—65
	Plotosus spp.	50—75
	Upeneus spp.	55—75
	Teuthis spp.	60—75
	Pelates sp.	30—60
	Sillago sp.	30—65
	Mugil spp.	20—60
	Scomberomorus spp.	65—90
Ola valai (Palk Bay)	*Psammoperca waigaiensis*	40—80
	Lethrinus spp.	50—200
	Lutianus spp.	50—200
	Leiognathus spp.	20—75
	Lactarius sp.	30—80
Experimental: light fishing (Gulf of Mannar)	*Sardinella gibbosa*	60—90
	Stolephorus spp.	40—65
	Ilisha spp.	60—80
	Leiognathus spp.	30—65
	Gazza spp.	30—60
	Plotosus spp.	60—90

(Sekharan 1959). It would appear that the shoals break up or migrate to deeper waters during day-time. But after June, the shoals are spotted near the surface during day-time also; a change of habit with increase in size is thus apparant.

Observations on the reactions of juveniles to light

(i) *In the fishery*: In the fishery using light, torches made of dried palmyrah leaves are employed. When a torch is lighted near a luminescent patch (shoal), the juveniles rapidly move towards it and around the boat. The torch is held about 1½ metres above the surface of the water. The fishes, especially the sardines, anchovies and *Atherina* spp. even jump towards the light. Sometimes they crowd the entire near-shore region right up to the water's edge. Stationed about 75 metres from a palmyrah torch, I could collect thousands with the bucket of a ½ m plankton net.

(ii) *During experimental light fishing*: First a 300 cc kerosene petromax light was used above the surface of the water. This was later substituted by an electric bulb, with power varying from 100 to 400 watts. Later on, a submerged light with power ranging from 6 to 21 watts was used. A dip net was arranged beneath the light. It was noted that "while the submerged light by itself was not effective, a combination of this with surface illumination gave a much bigger catch than either of the lights used singly" (Chellappa 1959). Only occasionally were sardines and anchovies seen in the catches; moreover they came in ones and twos and not in shoals. *Plotosus* spp. on the other hand appeared in groups of 10-15.

(iii) *Independent experiments conducted during this study*: An ordinary electric torch (with two cells) was used in the Palk Bay on dark nights. As soon as the beam strikes the water surface, *Atherina* spp. jump out of the water. When the beam moves along the surface, the fish along the track jump out, and falling back, create a sound like the patter of rain drops falling on water surface. Sardines were not seen during these trials, probably because they move in groups and not as individuals. Other fishes were not observed in the course of these trials.

In the evenings small sized *Mugil* spp. were seen along the water's edge in the Palk Bay and Gulf of Mannar.

Important fishes in the nearshore region

The data collected showed that *Sardinella* spp., *Hilsa kelee* and *Stolephorus* spp. comprise the bulk of the juveniles (about 85%) in

the nearshore region, during the March-June period. Among them, *Sardinella* spp. are dominant, in terms of both numbers and mass. To some extent, this may be correlated with the food of these fishes.

Food of important species of juveniles: On a few occasions the stomach contents of different species of fishes from the nearshore region were examined. The important elements are mentioned below:

Sardinella spp.	*Hilsa kelee*	*Stolephorus* spp.
Copepod nauplii and Copepodites	Copepods	*Lucifer* spp.
Copepods	Zoea	Copepods
Zoea	Lamellibranch larvae	Other Crustacea
Lamellibranch larvae	Diatoms (only small quantities)	
Gastropod larvae		
Diatoms		
Dinoflagellates		

Ilisha spp.	*Leiognathus* spp.	*Gazza* spp.
Copepods	Copepods	Copepods
Larger crustaceans	Decapod larvae	Decapod larvae
Diatoms (very few)	Diatoms (very few)	Diatoms (very few)

It may be seen that the conformity of the food spectrum with net plankton is more in the case of *Sardinella* spp. than in the case of other species, which explains, at least partly, the dominance of the former in the nearshore region.

The relative importance of Sardinella albella and S. gibbosa: Of the species of *Sardinella,* only *Sardinella albella* and *S. gibbosa* are important, the others forming less than 0.5 per cent of the sardine catch. Between the two species, *S. albella* is the more important one, on seasonal average. The ratio between the two species (in numbers) in 1952, 1953, 1954 and 1955 respectively was 7:2, 7:3, 20:19 and 13:12 in torch-and hand-net catches, and 3:2, 7:8, 17:12 and 1:5 in shore-seine catches.

Discussion

Since *Sardinella* spp. comprised the bulk of the biomass of juveniles in the nearshore region, the entire group may be termed the "*Sardinella* complex". It would be interesting to find whether *Sardinella* spp. are associated with the same or related species in other regions of the east and west coasts of India.

As *Sardinella* spp. occupy a lower trophic level than other fishes, the dominance of the former in the nearshore region is explicable. But

the dominance pattern between the two species of *Sardinella* in the nearshore region cannot be satisfactorily explained in terms of feeding relationships alone. Both species occur in the same haul, feed on identical items with little indication of any item being taken more by one species than by the other (Sekharan 1970). Ivlev's (1961) experiments show that the feeding of a species in an area may be adversely affected by the mere presence of another species; the effect would obviously be reflected in the magnitude of the two populations in the area. It is also generally contended by ecologists that two species with the same ecological requirements cannot co-exist in the same habitat (Gause's theory). Therefore, on these considerations, equal abundance of the two species in the area is not to be expected. But the seasonal data indicate near parity in the relative abundance of the two species. This is of course not true of short-term periods within a season, for which the pattern is not constant; the dominant species was *Sardinella albella* in some periods but *S. gibbosa* during others, both in numbers and in biomass. Viewed in this light, the situation here would not run counter to Gause's theory.

It was however apparent that the balance between the two species was delicate and could even be upset in the future. In the Gulf of Mannar, *S. gibbosa* was the dominant species of *Sardinella* while in the Palk Bay, the inter-specific 'struggle' for dominance appeared to be still on. A reversal of the observed pattern of species abundance in the Palk Bay could therefore be visualised.

The Palk Bay fishery for juveniles is a good example of commercial sampling of young fishes. Considerable time and expense are involved in the scientific survey of juveniles in fishery biological work. If commercial fisheries on the Palk Bay model could be established in areas where young fish are suspected to congregate, it would be advantageous in fisheries research work.

The recent decline in torch-and hand-net fishing (Dr. R. V. Nair, personal communication) calls for a serious study. Compared to the 1950's the character of the fisheries in the Palk Bay had changed considerably in 1960's with a concomitant increase in mechanisation of boats. The fishery for *Leiognathus* spp. is of much greater importance now-a-days than formerly. If the abundance of sardines has declined, it has to be determined to what extent the decrease is fishery-dependent. Similarly the effect, if any, of the recent changes in the fishing methods in the Palk Bay on the eco-system and the balance of the populations there merits an investigation.

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A new species and notes on the genus *Anthoxanthum* L. (Poaceae)[1]

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(*With three text-figures*)

A new grass *Anthoxanthum borii* is described. A dichotomous key is provided for identification of the six species of the genus *Anthoxanthum* L., occurring in India. Important distinguishing characters of the new species are also illustrated in a text-figure. Some critical notes on the identity of certain taxa are given.

Introduction

The genus *Anthoxanthum* L. was formerly included in the tribe Phalarideae of the subfamily Pooideae (Hooker, 221; Bor, 163, 1940; Hitchcock, 549); it is now placed in the tribe Aveneae (Bor, 431, 1960; Hubbard, 433).

Anthoxanthum L. is a large genus of about 50 species and numerous varieties (Chase & Niles 1962), distributed in almost all continents, particularly in Europe, the Mediterranean region and Old World.

The material of the genus from the herbaria at Shillong (*ASSAM*), Coimbatore (*MH*) and Calcutta (*CAL*) was examined; this included two type specimens of *A. hookeri* (Griseb.) Rendle and *A. sikkimense* (Maxim.) Ohwi.

Four species, namely *A. clarkei* (Hook. f.) Ohwi; *A. hookeri* (Griseb.) Rendle, *A. odoratum* L. and *A. sikkimense* (Maxim.) Ohwi are reported to occur in different parts of India, particularly in the eastern Himalayas and peninsular India. *A. puelii* Lec. & Lam., a grass from southern Europe, is comparatively a recent introduction in India.

One new species occurring in south India was discovered.

Anthoxanthum L. Gen. Pl. ed. 5:17, 1754.

Annual or perennial. *Leaves* up to about 10 mm wide. *Inflores-*

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cence a spiciform or lax panicle. *Spikelets* oblong to linear-lanceolate, slightly laterally compressed, rhachilla disarticulating above the glumes. *Glumes* 2, persistent, 1-3-nerved, 1-keeled, acute or acuminate, upper longer. *Florets* 3, heteromorphous; *first* (*lowest*) *floret* male, sometimes barren; *lemma* oblong-lanceolate, 5-7-nerved, hairy, shortly awned; *palea* 2-keeled, *lodicules* 0; *stamens* 3; *second* (*middle*) *floret* barren. *Lemma* and *palea* similar to that of lowest floret; *awn* longer, kneed, arising from near the base or from the middle. *Third* (*terminal*) *floret* hermaphrodite; *Lemma* much shorter than the lower two, broadly elliptic-lanceolate, delicately 1-7 nerved; *palea* 1-nerved; lodicules 0; *stamens* 2; *styles* distinct; *stigmas* 2, long, exserted from the tip of the spikelet, plumose. *Grain* ovoid, slightly laterally compressed.

Etymology: *anthos*: flower; *xanthos*: yellow, refers to pale yellowish inflorescence. Type species: *A. odoratum* L.

Key to species

1. Spikelets less than 5 mm long; awns projecting, $\pm$ equal to the spikelet itself .... *A. sikkimense*
1. Spikelets more than 5.5 mm long; awns projecting equal to, or much less than, the spikelet:
2. Spikelets very shortly awned, awn not projecting more than 2 mm beyond the spikelet:
3. Perennial; culms unbranched .... *A. odoratum*
3. Annual; culms branched, geniculate below .... *A. puelii*
2. Spikelets with long awns, awns projecting more than 2 mm beyond the spikelet:
4. Spikelets about 5.5 mm long; pedicels glabrous; lower and upper glumes acute (not acuminate); lemmas densely brownish hairy .... *A. clarkei*
4. Spikelets more than 6 mm long; pedicels glabrous or hairy, lower and upper glumes acuminate, lemmas less hairy, hairs hyaline:
5. Culms unbranched; leafblades up to 5 mm broad; ligule longer than broad; pedicels glabrous; lower glume about half as long as the upper, rarely more; inflorescence slender loose .... *A. hookeri*
5. Culms branched; leafblades up to 10 mm broad; ligule broader than long; pedicels hairy; lower glumes usually exceeding half the upper glume; inflorescence congested .... *A. borii*

The distinguishing characters of the new species have also been illustrated in the plate. In the following account, the species are arranged alphabetically. The new species is described in detail; for others, full descriptions are omitted as they are available in published literature, to which references have been cited.

Anthoxanthum borii sp. nov. (Figs. 1-3)

Anthoxanthum borii sp. nov. similis *A. hookeri* sed culmis ramosis, foliorum laminis latioribus, pedicellis pilosis, paniculis congestis differt.

Holotype: Pulneys, Pambar stream, near Shenthadikanal, 6-xii-1898. *Bourne* 1954 (CAL).

Anthoxanthum borii sp. nov. resembles *A. hookeri* (Griseb.) Rendle but differs in having branched culms, broad leaf blades, hairy pedicels and congested panicles.

A perennial rhizomatous grass, culms branched, erect, slender 0.6-1 m tall. Roots shallow. *Leaf sheaths* compressed, glabrous, slipping, from the culms; *leaf blades* linear, 8-30 cm long, 4-10 mm wide, rounded at the base, acute, glabrous or sparsely hairy; *ligule* truncate, membranous, hyaline, up to 3 mm long. *Inflorescence* a congested panicle, up to about 13 cm long, 2 cm wide; racemes short. *Spikelets* oblong-lanceolate, including the awn: 8-10 mm long, excluding the awn: 6-7 mm long, 1.5-2 mm broad, on short hairy pedicels. *Lower glume* ovate-lanceolate, acuminate, 4-5.5 mm long chartaceous, 1-nerved, *upper glume* ovate-acuminate, 6-7 mm long, 3-nerved, 1-keeled, keel scabrid, margins broad hyaline. *First* (*lowest*) *floret* male or barren; *lemma* 5-6 mm long, thin, membranous, 5-nerved, mid-nerve distinct, others faint, pilose with brown hairs, 2-lobed, lobes incised, awned in the sinus, awn up to or slightly exceeding the lemma; *palea* hyaline, linear-lanceolate, 4-5 mm long, 2-keeled, glabrous; *stamens* 3 or fewer, *anthers* 2-2.5 mm long. *Second* (*middle*) *floret* barren, lemma 4.5-6 mm long, oblong-lanceolate, obtuse, bifid, hairy, awned from the back at about the middle or lower down, awn slender, scabrid, geniculate, 6-9 mm long. *Third* (*upper*) *floret* hermaphrodite, *lemma* almost rotund, obtuse or acute and shortly aristate, 2.5-3 mm long, hyaline, very faintly 5-7 nerved; palea lanceolate, about 2 mm long; stamens 3 or 2; anthers 2-2.5 mm; *stigmas* 2, long, sometimes protruding beyond the floret; *lodicules* not seen.

INDIA: Tamil Nadu, Palnis, Pambar stream near Shenthadikanal, 6-xii-1898, *Bourne* 1954.

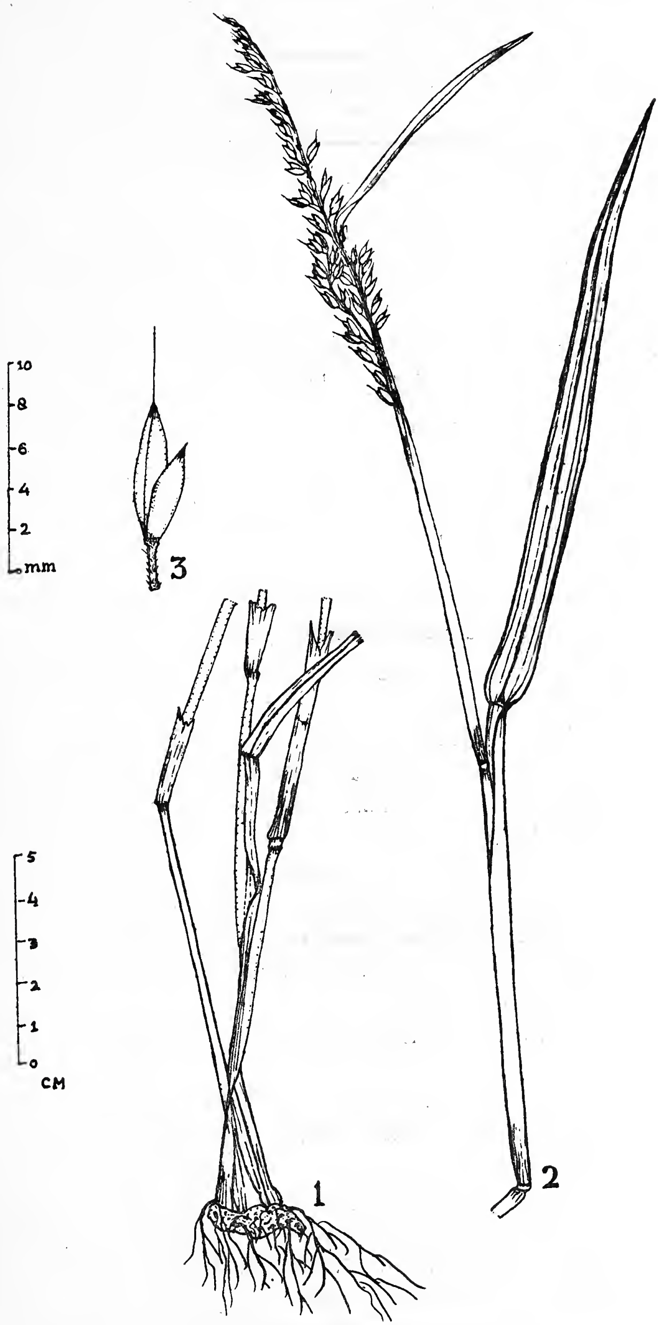
Distribution: India, so far endemic in Tamil Nadu.

Etymology: The grass is being named in honour of Dr. N. L. Bor, who first suspected this taxon to be new.

Critical note:

The third floret in our new species is normally unawned, but one of the sheets of Bourne (No. 1954, *CAL* 533452) shows the lemma of the third floret also shortly aristate. This character seems to be variable, as already recorded by Hubbard (p. 235) in an allied genus *Arrhentherum* P. Beauv.

Anthoxanthum borii resembles on the one hand, *A. hookeri* (Griseb.) Rendle, and on the other, *A. clarkei* (Hook. f.) Ohwi. The following



Figs. 1-3. *Anthoxanthum borii*. 1. Base of plant; 2. Culm bearing leaf and inflorescence; 3. Spikelet.

table brings out the distinguishing characters between these species and should help in identification.

Anthoxanthum borii sp. nov.	*Anthoxanthum hookeri* (Griseb.) Rendle	*Anthoxanthum clarkei* (Hook. f.) Ohwi
Leaves up to 10 mm broad	4-6 mm broad	Up to 4 mm broad
Panicle congested	Panicle loose	Panicle loose
Pedicels of spikelets hairy	Glabrous	Glabrous
Spikelets 6-7 mm long	6-7 mm long	5.5 mm long
Lower glume about 2/3 of the upper	Lower glume half as long as upper or shorter	Lower glume 2/3 or more than 2/3 of the upper
First (lowest) floret male	Male	Neuter
Second (middle) lemma 4.5-6 mm long	4-6 mm long	3.4.5 mm long, brown pilose
Third (upper) lemma rotund	More or less lanceolate	More or less lanceolate

Anthoxanthum clarkei (Hook. f.) Ohwi

Anthoxanthum clarkei (Hook. f.) Ohwi in Bull. Tokyo Sci. Mus. 18:8, 1947; Bor, 431, 1960.

Hierochloe clarkei Hook. f. Fl. Br. Ind. 7:223, 1896; Bor, 167, 1940.

Specimens examined: Arunchal: Jabrang, 2744 m, 15-xi-1951, *G. K. Deka* (*ASSAM* 20945); Arunachal: Jabrang, 16-x-1955, *Seshagiri Rao* 1289, (*ASSAM* 20944).

Distribution: Eastern India, Burma.

Etymology: The species is named in honour of C. B. Clarke.

Anthoxanthum hookeri (Griseb.) Rendle

Anthoxanthum hookeri (Griseb.) Rendle in J. Linn. Soc. (Bot.) 36:380, 1904; Bor, 431, 1960.

Hierochloe hookeri (Griseb.) Clarke ex Hook. f. Fl. Br. Ind. 7: 223, 1896.

Specimens examined: Sikkim, 2700-3600 m, *J. D. Hooker* s. n. (*CAL*) (Type); Sikkim: Zemu Valley, 2850 m, 9-vii-1909, *Smith & Cave* 1036 (*CAL*).

Distribution: Eastern Himalayas.

Etymology: This species is named in honour of J. D. Hooker.

Critical note: The grass described by Fischer (1846) under this name is actually *A. borii* Jain et Pal.

Anthoxanthum odoratum L.

Anthoxanthum odoratum L. Sp. Pl. ed. 1, 28, 1753; Hooker, 222;

Bor, 431, 1960; Hubbard, 271.

Specimens examined: Assam: Sept. 1936, *N. L. Bor* 13765 (*ASSAM* 32589); Meghalaya: Shillong, 1400-1500 m, 22-vi-1937, *N. L. Bor* s.n. (*ASSAM* 32590); Meghalaya: Shillong, 3-vi-1937, *G. K. Deka* 13998 (*ASSAM* 32592); Meghalaya: Shillong, 1500 m, 18-v-1938, *G. K. Deka* 20354 (*ASSAM* 32591); Meghalaya: Shillong 20-v-1957, *G. Panigrahi* 4780 (*ASSAM* 23269); Madras: Nilgiri, 2400 m, 24-i-1957, *K. M. Sebastine* 2214 (*MH* 4277); Madras: Kodaikanal, 19-iii-1950, *D. Daniel, S. Roy and J. S. Rao* s.n. (*MH* 93869); Madras; Ooty, 2220 m, 14-ix-1930, *V. Narayanaswami,* 4345 (*MH* 30312).

Distribution: All hilly regions of India; often cultivated; occasionally escape and run wild; Europe to Asia.

Etymology: The specific name refers to its odoriferous nature.

Anthoxanthum puelii Lecoq. et Lam.

Anthoxanthum puelii Lecoq. & Lamotte Cat. Pl. France 385, 1847; Hubbard 269.

A. aristatum Boiss. Bor, 164, 1940.

The following sheets in the *ASSAM* herbarium bear the annotation *A. aristatum* Boiss.

1. Shillong, Morollos' Compound, 1-vi-1937, Bor 13997 (*ASSAM* 32593).
2. Shillong, Lake garden, 3-vi-1937, Deka 13998 (*ASSAM* 32594).
3. Shillong, 21-iv-1941, Dhar 20653 (*ASSAM* 32595).

The first two sheets have been identified by Bor; and sheet No. 1 bears a note by him "This is a European grass. Found in Morollos' Compound, 1-vi-37. Probably introduced and run wild. Sweet vernal grass—Bor".

The characters by which the grass differs from *A. odoratum* L. have been brought out in the key; these are based on Hubbard (p. 269), Hitchcock (p. 549) and Bor (p. 164, 1940). Our examination also shows that these specimens from Shillong agree with these characters.

It may be mentioned here that Hubbard (p. 269) has described this grass under the name *A. puelii* Lec. & Lam. He and Hitchcock (p. 818) have recorded that many authors consider *A. aristatum* Boiss. and *A. puelii* Lec. & Lam. to be synonymous.

This grass grows along with *A. odoratum* L.; Deka collected both species on 3-vi-1937 from the same spot, and erroneously gave the same field No. 13998 to both.

Anthoxanthum sikkimense (Maxim.) Ohwi

Anthoxanthum sikkimense (Maxim.) Ohwi in Bull. Tokyo Sci. Mus. 18:8, 1947; Bor, 431, 1960.

Hierochloe gracillima Hook. f. Fl. Br. Ind. 7:223, 1896; Bor 166, 1940.

Specimens examined: Sikkim: 3300-3600 m, J. D. Hooker, s.n. (*CAL*) (Type).

Distribution: Eastern Himalayas.

Etymology: The species is named after its type locality, Sikkim.

Conspectus of synonymous names

The synonyms appearing in the foregoing account of the genus *Anthoxanthum* L. are listed below. Many binomials published under the genus *Anthoxanthum* L. refer to grasses which are not *Anthoxanthum* at all, but belong to other genera; several such names relate to grasses occurring in India and are included in following table:

Synonym	Correct Name
Anthoxanthum aristatum Boiss.	*Anthoxanthum puelii* Lec. & Lam.
A. avenaceum Retz.	*Dimeria avenacea* (Retz.) C.E.C. Fischer
A. gracillimum (Hook. f.) Mez	*Anthoxanthum sikkimense* (Maxim.) Ohwi
A. indicum L.	*Perotis indica* (L.) O. Ktze.
Ataxia hookeri Griseb.	*Anthoxanthum hookeri* (Griseb.) Rendle
Hierochloe clarkei Hook. f.	*A. clarkei* (Hook. f.) Ohwi
H. hookeri Maxim.	*A. hookeri* (Griseb.) Rendle
H. hookeri (Griseb.) Clarke ex Hook. f.	*A. hookeri* (Griseb.) Rendle
H. sikkimensis Maxim.	*A. sikkimense* (Maxim.) Ohwi
H. gracillima Hook. f.	- do -

Acknowledgements

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Bionomics and immature stages of the Barleria Lacebug *Habrochila laeta* Drake Heteroptera: Tingidae[1]

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(*With two text-figures and three graphs*)

The life history and population fluctuation for the three principal seasons of *Habrochila laeta* Drake has been studied. The nymphal stages have been described in detail. Graphs relating to growth rates of various parts of the body to the body length have been provided.

Introduction

Tingid bugs, also known as lace wing bugs are phytophagous insects which often inflict appreciable damage to plants due to their habit of feeding on plant sap and many species are known to be pests of crop plants. Studies on the nature of damage caused and biology are available of a few species namely *Telonemia surupulosa* Stal. (Khan 1945, Roonwal 1952), *Tingis beesoni* Drake (Mathur 1955), *Urentius echinus* Dist. (Patel & Kulkarny 1955), *Monanthia globulifera* Walker (Sharga 1953), *Stephanitis typicus* Dist. (Ayyar 1963, Mathen 1960, and Mathen *et al.* 1969), *Monastria minutula* Montandon, *Tingis buddleiae* Drake, *Cadmilos retiarius* Dist., *Urentius euonymus* Dist. (Livingston 1959, 1962 and 1968) and *Corythauma ayyari* Drake (David 1958, Dorge 1971). Mohanasundaram & Basheer (1963) have reported on the effect of weather factors on the population fluctuation of the Tingid, *Habrochila laeta* Drake, on *Barleria cristata* while David & Rangarajan (1966) noted it as one of the important pests of the flowering shrub *Barleria* spp. However, information on the habits, biology and immature stages of *H. laeta* appear meagre and the results presented here provide the necessary data.

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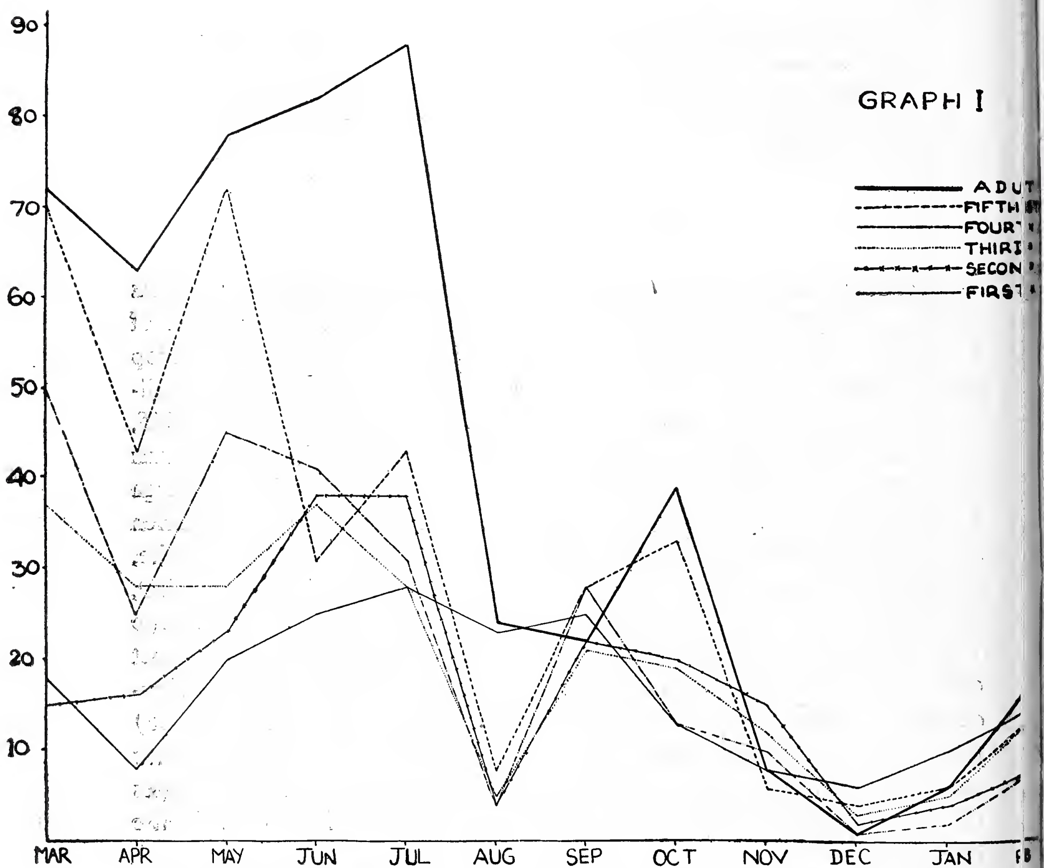
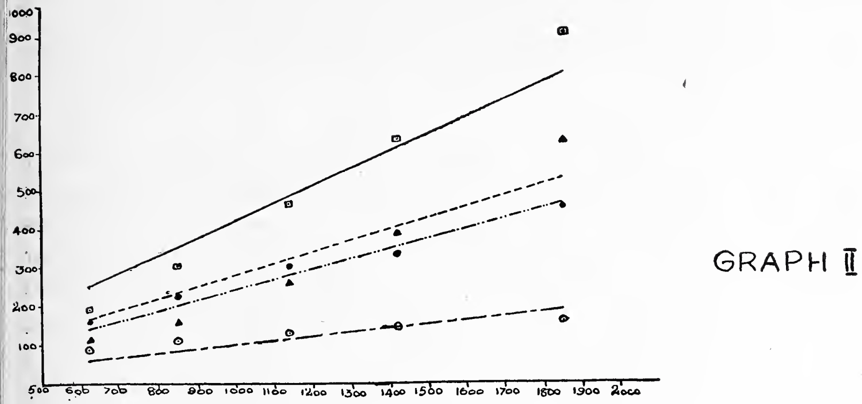
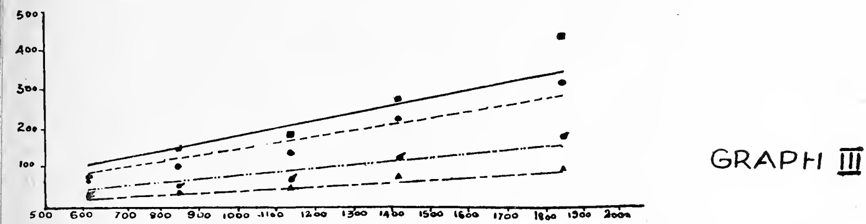
Material and Methods

The observations on the seasonal abundance and behaviour of the insect were made in a field at Poonamallee, near Madras. The population of the adult and different instar nymphs on ten leaves, collected at random was recorded at intervals of about a fortnight, during the period March 1971 to February 1972. The studies on the life history of the insect were carried out in laboratory. Temp. 29 ± 2°C, R. H. 75 ± 5%). The figures were drawn using a graticule and measurements were taken with a micrometer. Measurements of body parts of immature stages when plotted against body length have shown a linear relationship. The regression equations have been calculated using the formula Yc = a + bx, where 'Yc' is the calculated value of each observed value, 'a' and 'b' constants and 'x' body length. (Graphs II & III).



Graph I. Seasonal fluctuation of *Habrochila laeta* Drake during the period from 1971 March to 1972 February.





Graph II. Body width, width of Head, length of tibia and Tarsus in relation to body length.

⊡Width of Body; ●Width of Head;
▲Length of Tibia; ⊙Length of Tarsus.

Graph III. Antennal segments in relation to body length.

●—First segment; ▲Second segment;
■ Third segment; ●Fourth segment.

SEASONAL OCCURRENCE AND HABITS OF THE INSECT

The insect is found practically throughout the year on *Barleria cristata*. The population fluctuations of the adults and different nymphal instars for the three principal seasons are presented in Graph I. Infestation on the plant is more severe during summer months. The population is much reduced during monsoon and winter, perhaps due to adverse weather conditions. All the developmental stages occur on a single leaf and during peak infestations a single leaf may carry as many as 52 individuals of different stages. Adults and immature stages feed on the leaf content mainly from the ventral side causing the development of pale-yellow patches and ultimately shedding of the leaf. The younger ones, particularly the first and second instars show a gregarious tendency during feeding. The attack on the plant is gradual but severe. When the leaf is completely covered with excreta, the individuals migrate to fresh leaves. The adults have very weak wings and flying ability is very low. Dispersal takes place by contact and also

by wind. It was noticed that if the plants are cultivated in separate batches all of them may not be affected at the same time; whereas if they are planted in a row, infestation starts from one end and spreads to the other end.

Copulation and Egg laying

Females mate soon after emergence with males which mate only after 40 to 50 hours of their emergence. The process of mating is initiated by the male which approaches the female and flutters its wings for some time, before climbing over the female. Then the posterior end of the body of the male is bent posterolaterally and after two to three attempts it succeeds in copulating. Still attached to the female, the male slides down the female and takes it's position on one side of the female so as to make an angle of about 50°. The mating individuals do not feed but sometimes exhibit slight movements. They remain with heads turned downwards and antennae produced upwards. The whole process lasts for more than one hour (60 to 70 minutes). Similar type of mating behaviour has been reported for *Tingis buddleiae* Drake (Livingston 1968). The females were observed to mate only once in their life time, while the males mate three to four times with virgin females.

Pre-oviposition period lasts from 30 to 36 hours and oviposition period from 7 to 8 days. A female lays an average of 40 eggs in its life time.

The site on the leaf where eggs are laid varies in different species of Tingidae. *H. laeta* lays the eggs mostly on the dorsal surface on either side of the midrib of the leaves after making a small puncture with its gonopophysis. The process of egg laying lasts for 7 to 8 minutes. The eggs are always placed singly and in a slanting position. The opercular region projects out of leaf surface while the posterior part of the egg reaches the mesophyll (Fig. Ib). Two to three days after egg laying, the area of the leaf surrounding the egg becomes translucent. In the case of *Telonemia scrupulosa*, Roonwal (1952) observed gall formation in the leaf, where the egg is laid. No gall formation has been observed in the present study. Johnson (1936) and Livingston (1962) have reported smearing of the faecal fluid over the operculum in the eggs after its deposition in *Leptobrysa rhododendri* and *Dictyla suffata* respectively. No such smearing of the faecal fluid was noted in *H. laeta*.

Egg (Fig Ia)

Elongate, pale yellow, shining, marked with irregular sculptures on outer surface; micropylar part brownish, narrow; inserted end blunt. Outer surface of operculum irregular with brownish hexagonal sculptures. Eight to eleven faint longitudinal canals present in the polarito disci (Fig. Ic); canals lead to a circular canal present below the neck. The polarito disci similar to that of *Tingis*

stachydis (Stusak 1968). Basis operculari thick, continued through the outer part of chorion.

The incubation period during October-November has been found to be between 9 to 11 days. The process of hatching lasts for about

Fig. I

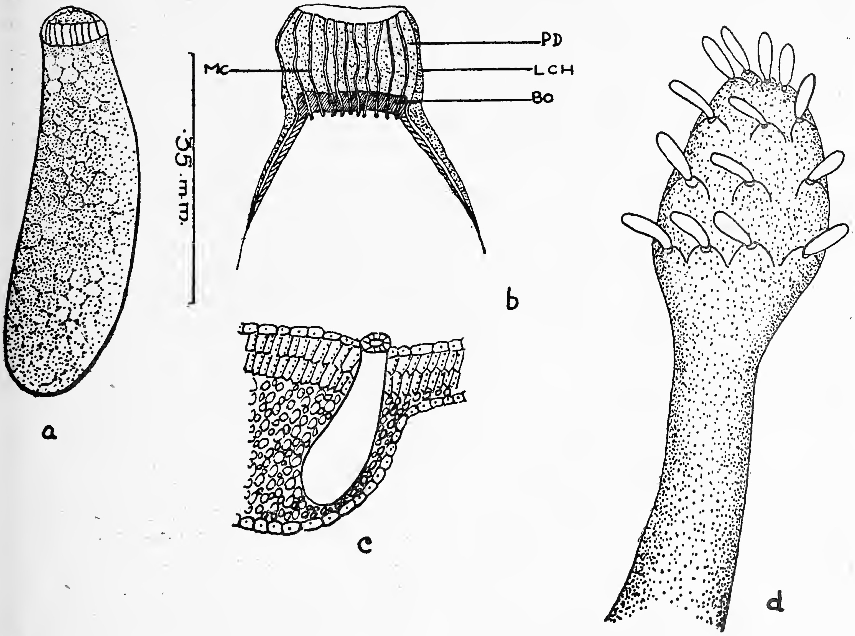


Fig. I. a—Egg; b—Opercular part of egg; c—Section of leaf showing the position of egg; d—Tubercle of the abdominal segment (enlarged). BO—Basis operculari; LCH—Limbs chorioni; PD—Polarito disci; MC—Microphylar canal.

ten minutes. The opercular region is lifted and pushed to one side along with a part of endochorion. The vertex of head emerges first followed by the first pair of legs which, after establishing a grip on the leaf surface draws out the body. For about 15 minutes the tiny whitish young do not feed, for the rostrum is attached to the ventral body by the ecdysial fluid.

First Instar (Fig. IIa)

Head markedly conical; clypeus prominent; anterior part of frons beset with three small protuberances two lateral and one median, each with a long spine, median spine bifurcated at base; vertex with a single protuberance bearing two spines; all the spines globulated; ecdysial suture prominent, reaching up to the second abdominal segment; antennae long, four segmented, hyaline and setose; terminal segment brown with the setae longer and thicker; rostrum hyaline, four segmented, with blackish fourth segment; stylets extend beyond rostral sheath. Eyes rose red with five ommatidia. Pronotum broad with straight anterior and convex posterior margins; median dorsal side with two protuberances one on either side of ecdysial suture, each with a spine; mesothorax

as broad as prothorax, with median tubercles placed a little away from the ecdysial line; metathorax narrow, without dorsal spines; pro, meso and metathoracic segments with spines laterally, one on each side; hind leg longer, coxa broad; trochanter indistinguishable; femur as long as tibia; tarsus unsegmented, brownish with two claws; setae present in distal segments, those of tarsus longer and thicker. Abdomen as broad as thorax; first segment narrow; second segment prominent with a pair of lateral tubercles and spines, median dorsal side with a tubercle bearing two spines; third and fourth segments similar with lateral tubercles and spines; fifth, sixth and eighth similar to second in tubercular arrangement; seventh and ninth to third and fourth; tenth narrow, conical with three or four sharp spines at tip.

Dorsal scent glands hardly visible between third and fourth and fourth and fifth segments.

The first instar moults to second instar between 48 to 60 hours.

Second Instar (Fig. IIb)

Slightly elongate, yellowish brown.

Clypeus elongate, anterolateral sides of the frons with protuberances each with a pair of spines; median dorsal side of the frons with a club shaped short tubercle bearing small scoli at its tip; similar tubercles present on vertices too; ecdysial suture similar to that of first instar; first two antennal segments equal in length; third longest; fourth longer than the first and second; first three segments of rostrum hyaline, fourth blackish brown, reaching only up to the second abdominal segment. Pronotum three times wider than long, with anterior concave, posterior straight and lateral convex margins; mesonotum with anterior straight, posterior concave and lateral convex margins; metanotum narrow; pro, meso and metathoracic segments bear lateral club shaped tubercles, one on each side. Legs similar and spinous. First segment of abdomen narrow, convex anteriorly and concave posteriorly; second similar to first but with a median dorsal tubercle; third similar to first but wider; fourth broader than third and bears a pair of lateral tubercles; fifth with dorsal and lateral tubercles; sixth similar to fifth in tubercular arrangement but narrow; seventh similar to fifth in the tubercular arrangement; eighth with a small stumpy dorsal tubercle and a pair of lateral processes bearing spines; ninth narrower than eighth and bears lateral processes and spines as on eighth; tenth tubular with four to six spines.

The second instar transforms to third after 30 to 38 hours.

Third Instar (Fig. IIc)

Elongate. Deep brown with a blackish tinge.

Anterior part of head oval; frons bears three club shaped stalked tubercles two fronto-lateral and one dorso-median. Of the four antennal segments, second smallest, third longest fourth longer than the first; eyes rose-red with 12 to 16 ommatidia. Prothorax large, almost half the size of entire thorax; with lateral tergal expansions extending little beyond the level of eyes; mesothorax smaller than prothorax but longer than metathorax; metathorax very small, median dorsal side alone is visible; tubercular arrangement as that of second instar. Abdomen oval. Second segment longer than the first with a median dorsal tubercle; fourth and fifth constitute the widest part of body; ninth segment with lateral club shaped tubercles; tenth with five to seven spines.

The third instar moults after 35 to 42 hours.

Fourth Instar (Fig. IId)

Broadly oval and blackish brown.

TABLE 1

MEASUREMENTS OF NYMPHAL INSTARS IN MM. EACH FIGURE IS AN ARITHMETIC MEAN BASED ON 10 INDIVIDUALS

Instar	Body		Width of	Length of antennal joints				Length of Rostrum				Length of hind leg	
	Length	Width	Head	I	II	III	IV	I	II	III	IV	Tibia	Tarsus
I	0.614	0.195	0.161	0.034	0.034	0.076	0.080	0.076	0.106	0.038	0.102	0.110	0.089
II	0.839	0.300	0.225	0.051	0.041	0.119	0.110	0.088	0.121	0.051	0.102	0.161	0.110
III	1.128	0.471	0.306	0.063	0.051	0.164	0.148	0.096	0.157	0.068	0.127	0.260	0.123
IV	1.414	0.632	0.335	0.102	0.076	0.263	0.215	0.140	0.187	0.079	0.143	0.396	0.147
V	1.844	0.926	0.459	0.178	0.085	0.442	0.319	0.178	0.246	0.085	0.178	0.629	0.166
Adult													
Male	2.046	0.892	0.467	0.348	0.110	0.952	0.378	0.204	0.263	0.110	0.178	0.969	0.170
Female	2.244	0.990	0.467	0.357	0.119	0.943	0.365	0.212	0.263	0.110	0.187	0.986	0.178

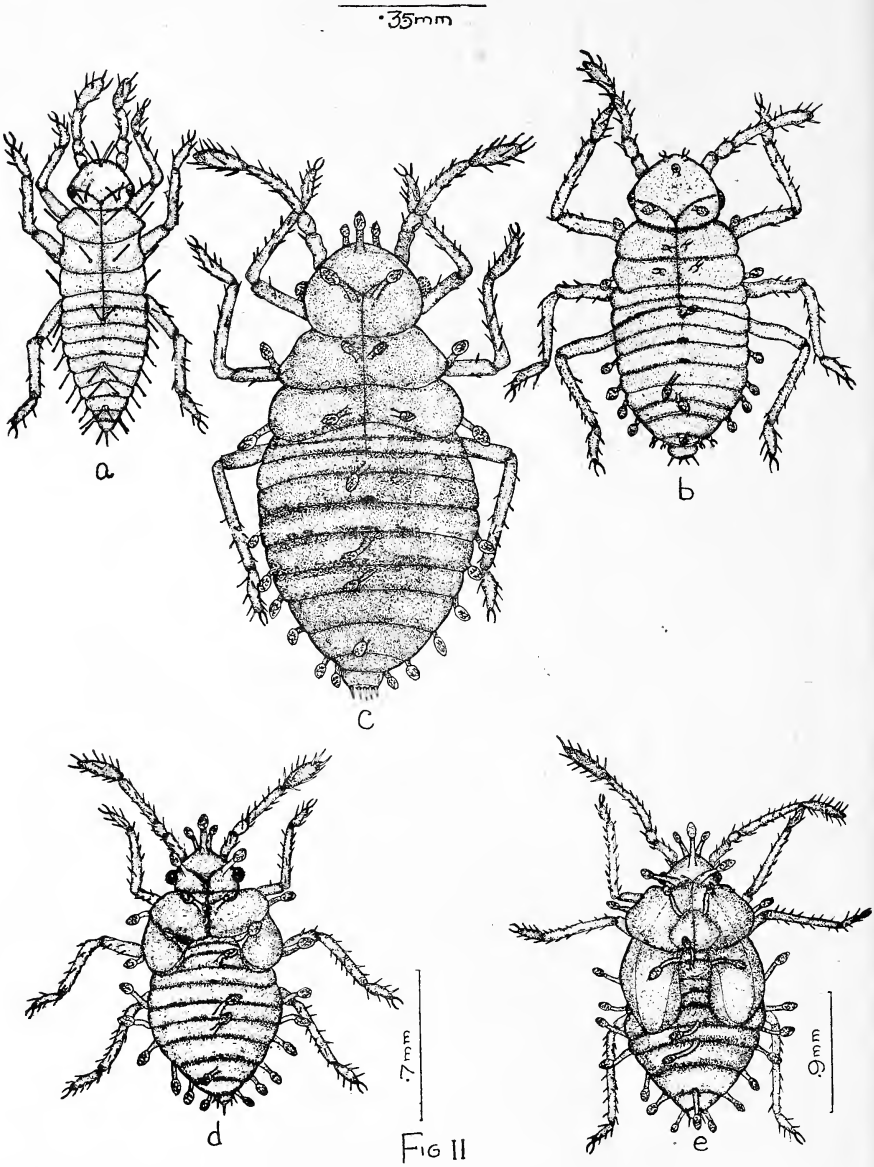


Fig. II. a—First Instar nymph; b—Second Instar nymph; c—Third Instar nymph; d—Fourth Instar nymph; e—Fifth Instar nymph.

Head oval with conical clypeus; head tubercles similar to those of third instar except for being longer; fourth segment of antenna deep brown with almost blackish bristles; rostrum reaches only up to the metathoracic segment; eyes deep brown with imbricately arranged ommatidia. Prothorax with straight anterior and convex lateral margins; posterior margin convex with a longitudinal cleft through centre, the ecdysial suture passing through it; metathorax with wing pads reaching upto third abdominal segment; outer margin of wing pads

convex, inner concave and posteiror blunt. The process of "translocation" (Stusak & Stays 1959) by which the tubercles of the mesothorax become associated with the wing pads occurs at this stage. Abdomen compact with tubercles similar to those of third instar; tenth segment very small with five to eight backwardly directed spines.

After 42 to 50 hours the transformation to fifth instar takes place.

Fifth Instar (Fig. IIe)

Oval. Blackish brown except for femur, tibia, proximal tarsus and first three antennal segments which are pale yellow.

Head roughly triangular; tubercles (Fig. Id) much longer and brown, those of vertices directed side ways; median part of vertex covered over by anterior extension of pronotum; eyes red brown with imbricately arranged ommatidia. Fourth segment of antenna black. Pronotum with large lateral and median anterior expansions; hood developed on its posterior side; dorsal spines of pronotum become associated with anterolateral sides of hood; wing pads long, reaching up to posterior limit of fifth abdominal segment; wing pads of metathorax smaller. Central part of abdomen forms the widest part of body; lateral sides of first five segments almost covered by wing pads; tenth segment very narrow with posteriorly directed spines.

The fifth instar moults to imago within 60 to 70 hours.

The adults were described by Drake (1954). The males are lighter in colour, shorter and narrower in size than the females.

General observations

At the time of moulting all the nymphal instars are whitish in colour which gradually turns to dull yellow in first and second instars, brownish yellow in third and blackish brown in fourth and fifth. The body surface acquires a shining texture after sometime. The fifth instar, white at the time of emergence, acquires a blue tinge a little later and finally turns to shiny black.

In all instars the Y-shaped ecdysial suture is not prominent at the time of moulting. It appears as a transparent streak after two to three hours. Dorsal abdominal glands which are hardly visible in the first instar become clearly visible in the second, third, fourth and fifth instars.

At the time of emergence of the imago, the hexagonal and pentagonal ridges of the hood are connected by a whitish membrane. This membrane later becomes transparent and the ridges blackish.

The adult males live from seven to eleven days and females from eight to fourteen days.

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Some observations on the colour changes of the Indian Chamaeleon[1]

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(*With a plate*)

INTRODUCTION

Chamaeleons are known for their ability to change colour rapidly. Interesting accounts on this aspect have been recorded by Hogben & Mirvish (1928), Hingston (1933), Zoond & Eyre (1934), Zoond & Bokenham (1935), Drimmer (1954) and Goin and Goin (1962). The work of these authors is on *Chamaeleon chamaeleon*, *C. pumulus* and *Lophosauria pumila*. In India, Trench (1912) recorded some observations on colour changes of the Indian Chamaeleon *Chamaeleon zeylanicus* Peters. However, these observations are casual and scanty.

In the present study, a young *C. zeylanicus* was collected on Rani Durgavati Samadhi road about 20 km south of Jabalpur. It was kept under observations in a large rectangular aquarium jar with branches of foliaceous shrubs. The animal was fed on grass-hoppers and water was provided by sprinkling on the branches. When the animal was seen adapted to captivity, the experiments on the colour changes were carried out.

OBSERVATIONS

The experiments were conducted under a fluorescent tube and white, yellow, red, blue and green backgrounds obtained by pasting transluscent coloured papers on the experimental jar. Observations were made from a small window left at one corner of the jar. The experiments were also conducted in coloured lights by employing colour-

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ed bulbs of 40 watt power. Out-door observations were made against the background and surroundings of green grass, yellow flowers and foliage of different shades. Several experiments spread over two days, were conducted for each background, colour and environment and only the results obtained consistently have been summarised in this paper.

Observations were also made for the whole day beginning from sun-rise to sun-set and twilight. At the end, some experiments were carried out by covering the eyes of the experimental Chamaeleon to study the role played by vision on the change of colour.

Experiments with different backgrounds

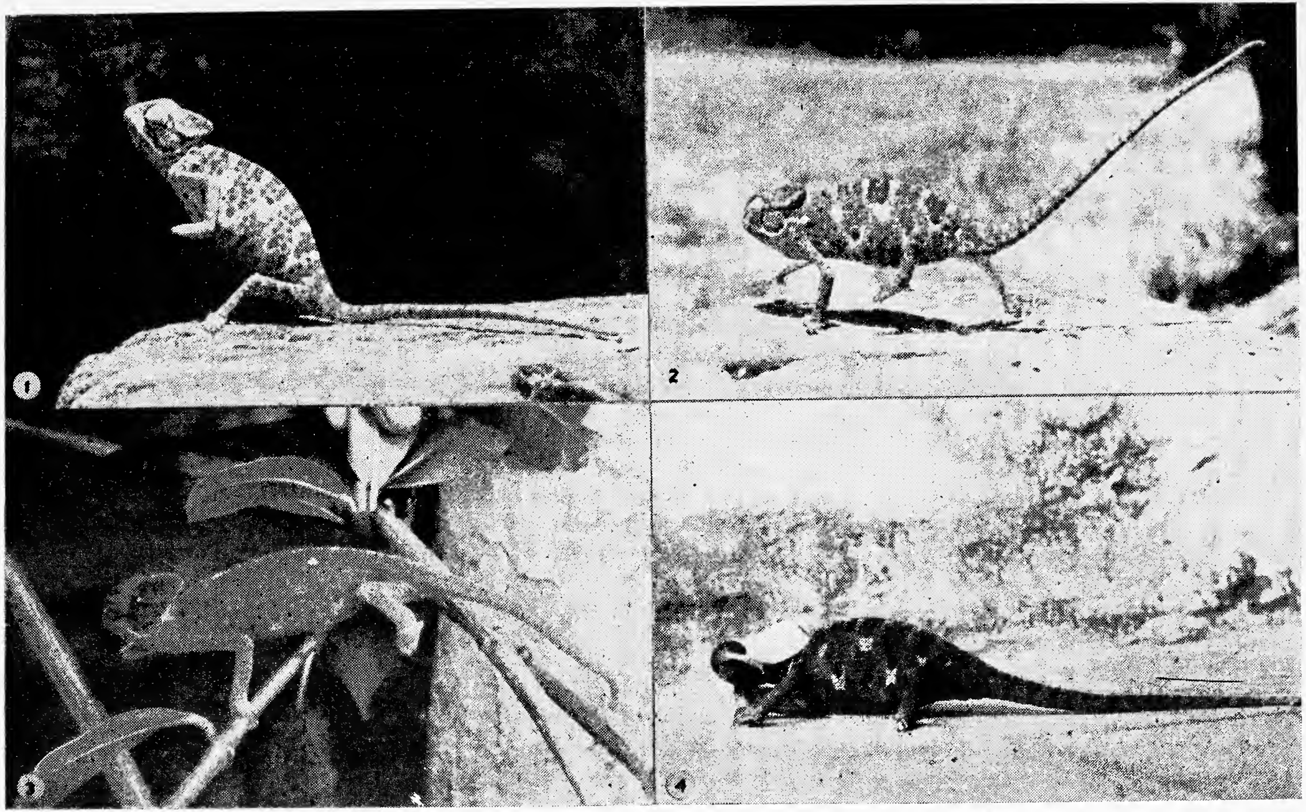
These experiments were conducted against white, red, yellow, blue and green backgrounds. The general pattern of the change of colours against these backgrounds is summarised in Table 1. The change in any colour pattern took about 3 to 4 minutes. There were minor deviations from the general pattern of the colour changes. These are given below.

TABLE 1

GENERAL PATTERN OF COLOUR CHANGES IN *C. zeylanicus* IN DIFFERENT BACKGROUNDS AND LIGHTS

Background/light	Colour pattern
	DIFFERENT BACKGROUNDS
White	Pale green with irregular blackish spots.
Red	Pale green with intermittent appearance of blackish spots.
Yellow	Dark green with black spots. Within 5-8 minutes, the black spots disappeared leaving the animal dark green.
Blue	Dark green. Black spots appeared for a short time.
Green	Dark green, perfectly matching the background. At times, pale green with light yellow bands.
	DIFFERENT LIGHTS
Red	Dark grey with light black spots. The side nearer the light darker than the opposite. Occasionally, black spots darkened and faded.
Yellow	Pale lemon yellow over the body and pale green on head.
Blue	Green with occasional black spots.
Green	Green with occasional black spots and yellow rings.

Plate I



Figs. 1 & 2. The colour pattern assumed in sunlight in the natural environment. Fig. 3 The colour pattern assumed in cover to simulate the surroundings of foliage and sunlight passing through the leaves. Fig. 4. Chamaeleon with eyes covered with rubber teats.

In white background on two occasions, the black spots became darker and the semi-circular lemon yellow rings appeared on the sides of the animal excluding its head. On tail, the rings were replaced by yellow vertical bands. When the light was switched off, the blackish spots on the body disappeared save a few small and lighter ones on the abdomen.

In red background, at one time, yellow spots of the size 8-10 mm appeared on the body along with vertical yellow bands on the tail. The spots on the body slowly changed to rings which later disappeared giving the chamaeleon the usual pale green colour with blackish spots.

In yellow background in the third experiment in the series, lemon rings appeared on the green body-colour in addition to black spots. The rings alternated the black spots. On tail, light yellow vertical bands alternated with pale green patches. Once the horizontal white stripes appeared on the body for a few seconds.

In blue background when the animal expanded its thorax, the portion in between ribs turned pinkish and later became light lemon yellow within a very short period. In the green background in one experiment, black spots appeared on the body momentarily.

Experiments with different lights

The general change of colour pattern in different lights for the chamaeleon under investigation is also summarised in Table 1. As in the case of backgrounds, there were some minor deviations in colour changes in these series of experiments. In yellow light in one experiment, the colour remained deep green. In blue light, the black spots used to disappear when the animal was at rest. On some occasions, the black spots alternated the yellow rings on the body while the tail remained green with vertical yellow bands. It may be mentioned here that the animal showed considerable movement in blue light.

Observations in natural environment

These observations were made from dawn to dusk. The temperature ranged from 27.5°C at 7.00 hrs to 35.6°C at noon and at 19.15 hrs it dropped to 26.2°C. The chamaeleon was allowed to move freely on a green shrub, grass, dried grass-land, stones, bricks etc., both in the shade and bright sun-light. Observations were made from a distance of more than 25 feet with a pair of binoculars and are summarized in Table 2. The changes in colour pattern could also be seen in Plate 1, Figs. 1 and 2.

Besides the colours shown in the Table 2, some interesting observations were made in this study. When a small bird landed on a branch of the shrub on which the chamaeleon was perching, the latter immediately developed dark black spots on the body and expanded its trunk assuming a grotesque posture. To avoid bright sunlight the animal entered thicker foliage. The colour pattern of dark green with

yellow spots developed at this time, is perhaps to simulate the surrounding foliage and the sun-light passing through the leaves. The side of the body facing the sun was darker than the other (Plate I, Fig. 3). Amongst the large yellow flowers of *Allamanda cathartica,* the colouring was so perfect that the animal was indistinguishable from a distance.

The observations in the natural environment tend to suggest that there is a daily colour rhythm in chamaeleon depending upon the weather, condition of light etc. This supports the observations of Waring (1963).

Observations with the animal's eyes covered

In order to study the role of vision in the change of colour in the chamaeleon, separate experiments were carried out. For the purpose, black ink dropper teats were cut to suitable size, smoothened by sand paper and fixed to the projecting eyes so as to cover them completely. They were further secured in position with the help of adhesive tape (Plate I, Fig. 4). This gave considerable discomfort to the chamaeleon and it tried to remove these by its forelimbs and rubbing its head against floor and sides of the experimental jar. The animal became disoriented and started walking backward and walking in circles when the eyes were capped.

The animal with its closed eyes was exposed to sun and also to the green, yellow, blue and red lights. The colour changes observed in these experiments are reported in Table 2. Here again, the side of the body nearer the source of light was darker than the opposite side. In the sun-light the colour changes to usual dark grey (Plate I, Fig. 4). There were thus slight deviations in the colour changes when the eyes were closed (Table 1 & 2). This tend to indicate the role of eyes along with the skin in the change of colour. This supports the views of Sand (1935), Drimmer (1954) and Portman (1959), that colour change is related to light, heat, emotional state and background colour.

General observations on colour changes

At times the grass hoppers given as food would sit on the back of the chamaeleon which would then turn grey or deep grey. The same reaction was given when the table on which the experimental jar rested was tapped or the animal touched by a glass rod. The animal was alive for five and half months. About 12 days before its death, it refused food and water and assumed lemon yellow colour which rarely changed. During these last twelve days it remained motionless closing its eyes. Even in this condition, it changed its colour to greyish in sunlight but not to black or deep grey as usual. In shade, it developed green patches on the general lemon colour. The colour of the body at the time of death remained lemon yellow all over.

Sand (1935) recognized five stages of progressive darkening in

TABLE 2

GENERAL PATTERN OF COLOUR CHANGES IN *C. zeylanicus* IN NATURE AND WITH COVERED EYES

Type of environment/ Experimental condition	Colour pattern
Early morning before sunrise.	Dark green which changed within 15 minutes to thick semicircular lemon yellow rings on the body and vertical bands on the tail.
Sun-shine on green shrub.	Dark green with yellow spots.
Yellow flowers of *Allamanda cathartica.*	Lemon yellow within two minutes.
Bright sunlight on dry grass.	Dark grey with the side towards light darker than the opposite.
Light shower of rain.	Pale yellow with greenish tinge on head.
WITH EYES COVERED	
Green, yellow and blue lights.	Green, at times changing to yellow rings and black spots.
Red light.	Grey with large dark black spots. The side nearer to light darker.
Sun-light.	Dark grey.

Lophosaura pumila. These stages are yellow, pale green, medium green, dark green and black. The Indian chamaeleon *C. zeylanicus* investigated here was found to change its colour in a few definite patterns namely, green, yellow and grey with black spots and/ or yellow rings and bands, irrespective of the background. Pinkish shade and white strips reported earlier are of rare occurrence. It will match only with green and yellow colours and their shades. With red colour, it changes to grey just as in bright sunlight. In blue or perhaps in any mild colour, it may remain green, yellow or shades of these two. This is more or less in accordance with the observations of Drimmer (1954). Fright response or defensive posture is indicated by a grey colour with black spots and expanded body to scare away the attacker. This supports the observations of Portman (1959) on *C. chamaeleon.*

Goin and Goin (1962) mention that the change of colour in Chamaeleon is in response to changes in light, heat and emotional state and not to the colour of the background. However, Drimmer (op. cit.) and Portman (op. cit.) believe it to be by both. The present study supports the views of the latter workers.

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A Catalogue of the Birds in the Collection of the Bombay Natural History Society—17

Picidae (concluded)

HUMAYUN ABDULALI

[*Continued from Vol.* **71** (2): 265]

495 specimens of 55 species and subspecies, up to No. 863 in INDIAN HANDBOOK and Registered No. 23788 are covered by this part. Mr. S. A. Hussain continued to assist.

818 **Dinopium benghalense dilutum** (Blyth) (Sind) Sind Golden-backed Woodpecker 4 : 69

4 : 3♂♂ 1♀ (by plumage)

1 Rawalpindi, 1 Nawashar, Jullundur, 1 Rawani, Sujabad, Punjab; 1 Gholan, Sind.

Northern birds of this species (*benghalense* and *dilutum*) can be separated from those from the south by the spotting/streaking on the throat showing an almost equal amount of black and white, *contra* largely black in the latter (*puncticolle* and *tehminae*).

Except for ♀ 10240 from Kumaon, Nainital district, the specimens listed under nominate *benghalense* and *dilutum* do not show any red on the upper body.

No. 10242 from Sind, a poor specimen, cannot be said to have paler upperparts than nominate *benghalense*, but is left here on distributional grounds. The others are distinguished by the slight olive wash on the upperparts, a character also visible in two juveniles from the Palnis (see under 821). ♂ No. 18559 from Delhi is also similarly coloured but considering that another (♀ 18560) also marked Delhi is typical *benghalense*, I am leaving them together.

Koelz's *girensis* from Junagadh, Kathiawar, is synonymised in IND. HANDBOOK with *dilutum* which is not shown to extend into Kathiawar. If not separable, it should presumably be synonymised with nominate *benghalense* which is accepted for this area.

Measurements under No. 821

819 **Dinopium benghalense benghalense** (Linnaeus) (Chandernagore) Goldenbacked Woodpecker 4 : 67

34 : 15 ♂♂ 19 ♀♀ (3 by plumage)

1 Kalesar, Jagadhri, 1 Ambala, 1* Bahawalpur, Punjab; 2 Delhi; 1 Bharatpur, Rajasthan; 1 Radhanpur, 1 Balaram, 1 Cambay, 1 Gir Forest, 1 Dohad, 1 Bodeli, Baroda, 1 Pandwa, 1 Laochali, Surat Dangs, Gujarat; 1 Sanchi, Bhopal; 1 Betul, 1 Antagarh, 1 Bhanupratappur, Kanker, C.P.; 1 Vizagapatam Hills; 1 Koira, 1 Barkot, 3 Badrama, Bamra, Orissa; 2 Baghowni, 1 Rajputtee, 1 Madhubani, 1 Tirhut, Bihar; 1 Meerut, 1 Cawnpore, 1 Salukapur, 1 Kumaon, Nainital, U.P.; 1 Calcutta.

Of the two from the Surat Dangs, the ♂ has a black chin with white spots and the coloured back of the south-western bird, but the white markings on the black forehead of the female are arrow-shaped as in the present group, and they are both left here. The two from Delhi have been commented on under 818. The young male has the forehead black as in the female but with no white markings.

Measurements under 821.

820 **Dinopium benghalense puncticolle** (Malherbe) (Nilgiris) Southern Goldenbacked Woodpecker **4** : 69

5 : 2 ♂♂ 3 ♀♀

1 Bamangoti, (T. R. Bell = N. Kanara); 1 Coonoor Ghat, Nilgiris; 1 Kurumbapatti, 1 Chitteri Range, Salem; 1 Seshachalam Hills, S. Cuddapah.

These specimens include some named *puncticolle* by Whistler when describing *tehminae* and are distinguished from most of the latter by the clearer yellow of the upperparts which lack the orange-red wash present in varying degrees in the others, a character not referred to in the description. The reference to the "orange-yellow" back of this race in the key to subspecies in IND. HAND. **4**:196 compared with "golden olive-yellow" in *tehminae* is confusing. The black shoulders are distinctive except in the topotype from Coonoor!

Malherbe's original description (1845, *Rev. Zool.*:404) does not isolate any subspecies now accepted. The throat is said to be black with white streaks (*albo striolatus*) while on the next page it is said that in the adult male the throat, front of neck and breast are deep black with numerous black (?white – HA) triangular spots. He adds that the female has the forehead and vertex of a deep black, sprinkled with *lance*-shaped white spots; such spots and the streaked throat are characteristic of nominate *benghalense* and though specimens from the Nilgiris are referred to, he states that it is common in Bengal and probably throughout India. Again he refers to the back and tectrices as orange-yellow washed with vivid red, none of which is shown in any of the present specimens. Malherbe also said that the young of *puncticolle* lacked the red on the upperparts and resulted in their being mistaken for *benghalense*.

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* ♂ 10259 from Bahawalpur was identified as halfway between *dilutum* and *benghalense* (Whistler, JBNHS **42**:733).

See remarks and measurements under 821.

821 **Dinopium benghalense tehminae** (Whistler & Kinnear) (Rajampura, 1350′, Panthalam Hills, Travancore) Kerala Goldenbacked Woodpecker.

21 : 7 ♂♂ (3 imm.) 14 ♀♀

1 Alibag, Kolaba District; 1 Dorh Village, 2 Ratnagiri; 1 Katgul, 1 Potali, 1 Kadra, 1 Alanki, 1 Anshi Ghat, 1 N. Kanara; 3 Manalur, Palnis; 1 Peermade, 1 Tekkadi, 3 Thirumalai, 1 Pulayanarkotta, 1 Maraiyur, 1 Jamestown, Kanyakumari.

The birds from the southwest lack the black shoulders and have their backs and upperparts orange-yellow, usually with a trace of red. The colour of the back also extends further towards the tail than in birds of the drier country further east. But when describing *tehminae* no reference was made to the richer orange-yellow of the upperparts with touches of red, though this is the most consistent and striking difference. Those from the Nilgiris are similar or intermediate and if the type locality of *puncticolle* must remain unchanged, *tehminae* will have to be synonymised with it; the birds from further east will then either need another name or be left unnamed as intermediate between nominate *benghalense* and the richly-coloured form in the southwest.

Two juvenile males (Nos. 10257 & 23759) are paler and have a greenish yellow wash above resembling the colour of those under *dilutum*.

	Wing	Bill	Tail
dilutum (3) ♂♂	140,147,148	37,37·5,39·5	–,85,87
(1) ♀	148	33·5	95
(♂♀	142-147	28-37	—)
benghalense (15) ♂♂	(133), 139-148 av. 144·2	32-38·5 av·35·5	83-92 av. 87
,, (19) ♀♀	135-148 av. 142·4	29-38 av. 34	81-93 av. 88·5
	(IH ♂♀ 136-148	from skull 31-43	89-93)
tehminae (4) ♂♂	143 (3)-148 av. 144·2	38,38·2,40,40·5	87 (2), 90
,, (4) ♀♀	140-148 av. 143·6	33·5-38·4 av. 35·6	80,85
puncticolle (2) ♂♂	138,143	37·5	80,85
,, (3) ♀♀	142,145,146	32·2,34·5,37·8	-,91,92

822 **Dinopium benghalense jaffnense** (Whistler) (Illipaikkadavai, Ceylon)

1 ♂ (by plumage) Ceylon.

In the single specimen available the chin is not black with white spots as in typical *puncticolle/tehminae*, but similar to that of nominate *benghalense*. The back has slight traces of red, while the front portion of the head is very weakly marked with red. The breast is heavily stained with brownish as in other South Indian birds referred to under 821.

823 **Dinopium benghalense psarodes** (A. Lichtenstein) (Ceylon) Ceylon Redbacked Woodpecker 4 : 71

2 : 1 ♂ 1 ♀

1 Opanake, Hunuwella Estate, Ceylon; 1 no data.

824 **Dinopium shorii shorii** (Vigors) (Himalayas) Himalayan Goldenbacked Threetoed Woodpecker **4 : 74**

8 : 5 ♂♂ 3 ♀♀

1* Kolatur North, S.I.R. (South Indian Railway, Madras); 1 Hazaria, Pattarghat, Bihar; 1 Partapur, Nepal; 4 *Kani, L. Chindwin;* 1 *Kamaing, U. Burma.*

	Wing	Bill	Tarsus	Tail
♂♂	148–159 av. 155	32–36 av. 35	24–27 av. 26	95,98(2), 102
	(IH 154–159	from skull 39–44	–	96–104)
♀♀	151,156,157	32,34,37	24,26,27	99,101,102
	(IH 152-164	37–41	–	99–104)

*See *JBNHS* **70**:200-201.

Except for the specimens from Bihar and Nepal, the others were all listed under *Chrysocolaptes guttacristatus* (Nos. 861/2).

There is no evidence that *Dinopium shorii* and *Dinopium javanense* are anywhere, at least in Indian limits, sympatric, and the difference between them may perhaps be of a subspecific nature.

825 **Dinopium javanense malabaricum** Whistler & Kinnear (Manantoddy, Wynaad) Malabar Goldenbacked Threetoed Woodpecker **4 : 73**

4 : 2 ♂♂ 2♀♀ (1 juv.)

1 Wynaad; 1 Santhanpara, Cardamom Hills, 2 Thattakad, North Travancore.

	Wing	Bill	Tarsus	Tail
2 ♂♂	137,140	31,31	22,23	92,95
	(IH 135–143	from skull 31–32	22–24	87–95
1 ♀	137	29	24	mltg.
	(IH 137–143	27–32	22–24	83–94).

826 **Dinopium javanense intermedium** (Blyth) (Nepal, Assam,.... Tenasserim = Arakan) Burmese Goldenbacked Threetoed Woodpecker **4 : 72**

4 : 2 ♂♂ 2♀♀

1 *N. Shan States*; 1 *Toungoo*; 1 *Ataran*, 1 *Tenasserim.*

	Wing	Bill	Tarsus	Tail
♂♂	144,154	30,31	25,26	95+,96
♀♀	-,150	29,30	24,25	95,102
	(♂♀ 136-165	27-30	23-24	85-102)

The two southernmost birds from Tenasserim have their wings appreciably smaller, approaching *javanense* q.v.

EL **Dinopium javanense javanense** (Ljungh) (Java)

1 ♂ Wellesley Province, Malaya. Wing 127; bill 25; tarsus 18; tail 82.

827 **Gecinulus grantia grantia** (Horsfield) (Assam) Paleheaded Woodpecker **4 : 27**

5 : 2 ♂♂ (1 by plumage) 3 ♀♀

1 Berrit, 600′ Sikkim; 1 Abor Country, 1 Dening, Lohit Valley, 1 Roop-

chena, Cachar, Assam; 1 1000′ *Wantho Range, Mu Forest Div., Kolha Dist., U. Burma.*

The last two, both females from south of the Brahmaputra are paler red, nearly pink above, and also have their heads and underparts much paler than in the others. One of them has the wing and tail quills in moult and this may represent a juvenile plumage, though IND. HANDBOOK (4:205) repeats Stuart Baker's statement that juveniles are like females but *dark brown on mantle and very dark chocolate brown on breast, flanks, and abdomen.*

	Wing	Bill	Tarsus	Tail
♂♂	128,129	23,25	24,24	82,85
♀♀	125,128,-	24,24,25	23,23,23	84,84,-
	(IH 125-134	from skull 25-27	23-24	79-87)

828 **Mulleripicus pulverulentus mohun** Ripley (Jamu Ghat, Bheri River, Western Nepal) Nepal Great Slaty Woodpecker

A yet unregistered male from Gaylegphug, C. Bhutan, measures wing 235, bill 58, tarsus 38, tail 150. In addition to the general colour being a darker grey, the bill is smaller than that of the next subspecies (829) than is indicated by the measurements.

829 **Mulleripicus pulverulentus harterti** Hesse (Type from Pya, Upper Chindwin River, Burma) Burmese Great Slaty Woodpecker **4:** 86

5 : 2♂♂ 3♀♀

1 *Yagyi,* 2 *Kani, Lower Chindwin,* 1 *Wuntho, Upper Burma,* 1 *Burma.*

	Wing	Bill	Tarsus	Tail
♂♂	236,244	61,68	30,39	152,152
♀♀	228,239,240	60,66,67	34,35,39	150,155,164
(♂♀	221-245	60-69	39-41	134-162)

The red patch on the cheeks of the male from Kani, Lower Chindwin, is smaller than that of the other from "Burma". The latter No. 10348 has several of the cream-coloured feathers of the upper neck splashed with red.

830 **Dryocopus javensis hodgsonii** (Jerdon) (Indian Peninsula; restricted type locality Telicherry) Indian Great Black Woodpecker **4 :** 90

10 : 6 ♂♂ 4 ♀♀ (1 juv.)

1 Songadh, Navsari Dist., 1 Laochali, 2 Mheskatri, Surat Dangs, Gujerat; 2 Kadra, 1 Supa Petha, N. Kanara; 1 Puttapudi, Travancore; 1 Amraoti, Bastar, M.P.; 1 no data.

	Wing	Bill	Tarsus	Tail
6 ♂♂	212-222 av. 216·8	57-63	34-37 av.35	156-166 av. 158
	(IH 213-225	from skull 63-69	37-43	139-165)
3 ♀♀	212,218,219	56,57,60	35(2),36	152,154,157
	(IH 212-226	from skull 59-65	36-39	130-170)

831 **Dryocopus javensis hodgei** (Blyth) (Andaman Islands) Andaman Black Woodpecker **4** : 91

5 : 2 ♂♂ 3 ♀♀
1 Long Island, Middle Andamans; 1 Ferrarganj, 3 Wrightmyo, South Andamans.

	Wing	Bill	Tarsus	Tail
♂♂	182,188	39,43	33,37	134,137
♀♀	180,187,190	40,42,45	32,32,35	130,141,144

I have already (*JBNHS* **61**:565) referred to one of the males in breeding condition from Ferrarganj, S. Andamans, having only half the head red, as in females, against all-red in another from Long Island, M. Andamans.

EL **Dryocopus javensis feddeni** (Blyth) (Pegu) **4** : 89
1 ♂ *Nyaungbinloy, Lower Chindwin, Burma.*
Wing 218; bill 47; tail 140.

EL **Dryocopus martius khamensis** (Buturlin) (Eastern slope of the great plateau of Tibet).
1 ♂ *Tomg Kyuk, S. Tibet.*
Wing 245; bill 51; tarsus 33; tail 158.

832 **Hypopicus hyperythrus marshalli** (Hartert) (Murree) Western Rufousbellied Woodpecker **4** : 31

7 : 3 ♂♂ 4 ♀♀ (1 by plumage)
1 Dunga Gali, Hazara, N.W.F.P.; 2 Narkanda 9000′, 1 Marnauli (?), Simla Hills; 2 Kidernath, 1 Ghat Gharwal.

	Wing	Bill	Tarsus	Tail
♂♂	120,120,126	26,27,28	20,21,23	72,73,80
♀♀	120.122,124,126	25,28,29,30	20,22(3)	62,66,74,77
(♂♀	126-136	25-27	–	–)

It is customary to accept birds from Garhwal and Kumaon as of this form, but their wings are smaller than mentioned in FAUNA *supra* and Vaurie (124-131 av. 127·2). However, all of them can be distinguished from the eastern birds by their much heavier bills, which difference unfortunately is not conveyed by the measurements.

833 **Hypopicus hyperythrus hyperythrus** (Vigors) (Himalayas, restricted to 'Nepal or further east' by Hartert) Eastern Rufousbellied Woodpecker **4** : 30

2 : 1*♂ 1♀
1* Bolnai, Manipur Hills; 1 *Mt. Victoria,* 8000′, *Pakokku Hill Tracts, Central Burma.*

Together with 9 specimens from Bhutan, yet unregistered, the slender bills are a more distinctive difference from *marshalli* than the slightly smaller wings, though the latter tendency appears to extend eastwards.

	Wing	Bill	Tarsus	Tail
6 ♂♂ Bhutan	116-125 av.120	21-25 av.23·7	19-22	73-88 av. 80
3 ♀♀ Bhutan	117,118,124	23,25,25	20,21,21	77,78,79
1 ♂ Manipur Hills	111	26	19	69
1 ♀ Mt. Victoria	108	25	18	68
(IH ♂♀	114-122	from skull 23-28	19-22	69-87)

Sp. No. 9980 from Mt. Victoria is the smallest. *H. h. heinrichi* (Stresemann) was described from this place, while Koelz described *H. h. haemorrhous* from Korong, Manipur. Both are synonymised with the nominate form by Vaurie (1965, p. 719), who also accepts Hartert's restriction of the type locality as above and saves a great amount of confusion.

EL **Dendrocopus leucopterus leucopterus** (Salvadori) (Yarkand, Kashgaria)

1 o?

Keriya, 4300′ (collected by A. Sherriff on 25 Feb. 1931).

Wing 128; bill 26; tarsus 22; tail 89.

The 6th primary agrees with that of Zarudny's *korejevi* from Kuldjin, Sinkiang, as illustrated in Vaurie's 'Systematic Notes on Pal. Birds' (*Am. Mus. Nov.* 1946, p. 15) but where this race is synonymised with the nominate.

EL **Picoides major tenuirostris** (Buturlin) (Western Transcaucasia)

1 ♂ Kusary, Azerbaijan, U.S.S.R.

Wing 130; bill 27; tarsus 21; tail 74.

EL **Picoides major cabanisi** Malherbe (Shantung).

6 : 5♂♂ (1 juv.) 1♀ All Temple of Heaven, Peking, China.

	Wing	Bill	Tarsus	Tail
♂♂	126,127,130(2)	29(3), 31	22,23,24(2)	79(2), 81(2)
♀	130	27	23	81

The males have broad orange-red patches of different shades on the nape. The juvenile male shows no colour on the head and the under-tail coverts are faintly marked. The underparts are washed with ochre *contra* white in *tenuirostris*.

834 **Picoides major stresemanni** (Rensch) (Tsalila, on the Yunnan-Sikang border) Blackcrowned Pied Woodpecker 4 : 34

nil.

835 **Picoides assimilis** (Blyth) (Himalayas, Rawalpindi) Sind Pied Woodpecker 4 : 35

11 : 4 ♂♂ 7 ♀♀

1 Lukh, 4300′, 100 m. south of Kalat, 1 Chaman, Baluchistan; 1 Karung (?), 1 Rawalpindi, N.W.F.P.; 3 Campbellpore, Punjab; 1 Sukkur, Sind;

1 Doulatpur (Sind Frontier); 1 Manthar; 1 City Environments, Bahawalpur.

The ♂ from Chaman was listed under *himalayensis* from which it can be readily distinguished by the white forehead and the larger patch of white on the scapulars. The 4 southern birds are smallest and have their underparts a purer white than the others, which show the range of colours referred to under *himalayensis* below.

	Wing	Bill	Tarsus	Tail
Northern ♂♂	119,120,124	26,27*,27·5*	18,19,20	68,70,73
Southern ♂	114	27	20	70
(IH ♂♂	114-123	from skull 28–31	-	71)
Northern ♀♀	115,116,117,120	24(2),26(2)	18,19(2),20	68,76
Southern ♀♀	110,112,115	22,24(2)	18(2),19	66,67,69
(IH ♀♀	111-120	24-27	-	65-70)

*In two males (Rawalpindi and Campbellpore) the bill is heavier at the base, *contra* one from Chaman and another from Sukkur, Sind. In both the latter, the head is orange *contra* red.

836 **Picoides himalayensis albescens** (Baker) (Goona [?], Kashmir) Kashmir Pied Woodpecker **4** : 34

11 : 4 ♂♂ (1 by by plumage) 7 ♀♀
1 Kilia Drosh, 3 Chitral; 1 Gora Gali, Murree, Punjab; 3 Liddar Valley; 1 Doossoo, 2 Kashmir.

See remarks under 837.

837 **Picoides himalayensis himalayensis** (Jardine & Selby) (Mussoorie, 6500′) Garhwal Pied Woodpecker **4** : 32

26 : 19 ♂♂ (3 by plumage + 1 juv.) 7♀♀ (3 by plumage)
1 Golhar, Kishtwar, Kashmir; 1 Dalhousie, Punjab; 3 Koti State, 9 Simla, 1 Himalayas (J. C. Anderson = Simla ?); 1 Dhakuri, 2 Mornaula, 1 Kumaon, 1 Ukhimath, 1 Kalia Ghat, 1 Garhwal; 1 Lambathach ?; 1 Surd 8000′, 1 Nishar 7000′?; 1 no data.

There is considerable variation in the colour of the underparts of these specimens and those listed under serial 836, and the descriptions in FAUNA and IND. HANDBOOK do not permit their division into two distinct races—hampered no doubt by the fact that the type localities are very close together and most of the material available is from an intermediate area.

Birds from the northern and higher portions of Kashmir together with those from further west have whiter underparts and are referred to as *albescens*. Adult specimens from Garhwal and Kumaon appear equally pale on the underparts but are listed under the nominate form.

The males appear to show colour on the head in the first plumage, when after the persistent black line the front half of the head is marked faintly and irregularly with orange-red spots. Later, the colour on the head extends to the top, and finally over the whole head. In the last

stage the colour turns crimson. The colour is always at the tip of the feathers and the black base shows through to a greater or lesser extent in all stages, no bird having a uniformly red head. Using the colour of the head as an index of age, the youngest have the underparts slightly streaked and appear greyish brown, the feathers around the tarsus showing a barred effect (Nos. 9988 and 10016 from Kumaon).

The colour of the underparts then changes and is palest and most uniform with a slight tinge of rufous in the adult. No intermediate sub-adult plumage is recognisable in the female.

Four (1 ♂ 3 ♀ ♀) from Kishtwar and Simla show irregular patches of dark rufous on the upper breast. Two such females from S. Basil-Edwardes's collection obtained on 27 and 29 August are marked "juv. ♀ " and "juv. ♀ ?". but a male from Koti State (20 January) similarly marked has the whole head red and is marked "Adult" by the collector A. E. Jones. This does not appear to be a character of juvenility.

	Wing	Bill	Tarsus	Tail
albescens				
ad. ♂♂ (4)	130,132,133,135	31,32,33 (2)	24,26 (2), 27	82,83,85,89
himalayensis				
ad. ♂♂ (5)	133-137 av.134·5	30-34 av.32	24-26	83-90 av.85
sub-ad. ♂♂	(7) 129-134 av.132	30-34 av.32	24-26	70-87 av.80
juv. ♂♂ (5)	121-130 av.125	24-26	20-26	70-83 av.76
albescens				
♀♀ (7)	127-131 av. 129·5	26-30 av.28	23-24	76-85 av.82
himalayensis				
♀♀ (6)	123-133 av.127	26-30 av,28·6	23-26	75-83 av.80
albescens ♂♀	127-136	28-32	-	-)
(*himalayensis* ♂♀	123-135	29-33	c.23-24	77-85)

Two males (by plumage) from Surd and Nishar are included in nominate *himalayensis* but the places are not traceable.

838/839 **Picoides darjellensis darjellensis** (Blyth) (Darjeeling and Nepal) Darjeeling Pied Woodpecker 4 : 36

1 no data.

Together with 3 ♂♂ and 2 ♀♀ from Bhutan, yet unregistered, the measurements are:

	Wing	Bill	Tarsus	Tail
♂♀	125-128	30-32	21-23	79-84
	(123-135	32-35	c.22-23	77-86)

840 **Picoides cathpharius cathpharius** (Blyth) (Darjeeling) Himalayan Crimsonbreasted Pied Woodpecker 4 : 37

1 ♀ Woodcot 5500′, Darjeeling District.

Including 4 yet unregistered specimens from Bhutan, they measure:

	Wing	Bill	Tarsus	Tail
2 ♂♂	99,101	18,19	17,18	58,65
3 ♀♀	98,98,100	18,19,20	17,18,18	60,62,63
(♂♀	97-101	16-17	c.15	59-60)

840a **Picoides cathpharius ludlowi** (Vaurie) (Tsera; Pome, south-eastern Tibet = south-east Sikang) (Tibetan Crimsonbreasted Pied Woodpecker

nil.

841 **Picoides cathpharius pyrrhothorax** (Hume) (Aimole, Eastern Manipur Hills) Crimsonbreasted Pied Woodpecker **4 : 38**

nil.

842 **Picoides auriceps auriceps** (Vigors) (Simla) West Himalayan Brownfronted Woodpecker **4 : 42**

30 : 16 ♂♂ (6 juv.) 14 ♀♀ (3 juv.)

2 Chitral, 1 Ghora Gali; 15 Simla, 1 Bhajji State; 1 Kishtwar, 1 Watur, 7 miles from Srinagar; 1 Jall, Tehri-Garhwal; 1 Garhwal, 1 Dwarkanath, 1 Lohaghat, Almora, 2 Chira, 1 Gurna, 1 Kumaon; 1 Nishar 7000′ (?).

Juvenile males have indistinct markings of red and yellow on the head, but lack the distinct patch of the same colours on the occiput. Juvenile females have various degrees of pale streaking on the centre of the feathers of the head.

The juveniles were all taken between "May" and 22 August.

	Wing	Bill	Tarsus	Tail
Ad. ♂♂ (6)	112-120 av. 116	23-25	18-20	68-74 av. 70·5
♂♂ (4)*	111,113,114,115	23(2),24(2)	19,20(3)	60,67,68,72
♀♀ (11)	112-117 av. 114	21-23	19-20	65-74 av.70
(♂♀	112-118	21-24	18-20	68-73)

*The foreheads of the four taken in April lack the smooth sheen of the adults, which difference together with the slightly smaller size suggests a sub-adult phase.

All the specimens appear to be from the accepted range of the nominate form, but the wing measurements intrude upon the limits of *incognitus* 105-115 indicated in the key between the two races (IND. HANDBOOK 4:221).

843 **Picoides auriceps incognitus** (Scully) (Valley of Nepal) Nepal Brownfronted Pied Woodpecker **4 : 42**

nil.

844 **Picoides atratus** (Blyth) (Tenasserim) Stripebreasted Pied Woodpecker **4 : 42**

2 : 1♂ 1 ♀

1 *Thayetmyo Dt., Burma*; 1 *French Indo-China-Laos.*

	Wing	Bill	Tarsus	Tail
♂♀	118,114	25,25	22,21	70,65
(♂♀	114-122	24-26	18-19	65-72)

845 **Picoides macei macei** (Vieillot) (Bengal) Indian Pied Woodpecker **4 : 39**

35 : 20 ♂♂ (5 by pl.) 14 ♀♀ (1 by pl.)

2 Patiala State, 1 Kalka, 1 Bhagat State, 3 Simla; 1 Sankarametta, 1 Lamasinghi, Vizagapatam; 1 Berbera, Puri Dt., 1 Simlipal Hills, Orissa; 1 Kumaon, Nainital; 1 Hetwada, 2 Bankulwa Morang, Nepal; 1 Dehra Dun, 1 Kurseong Division; 2 Bhutan; 3 Goalpara, 1 Dibrugarh, 1 Sadiya, 1 Tezu, Lohit Valley, 1 Cachar, 2 Dinapur Road, Manipur, 1 Assam; 5 *Upper Burma*, 1* *Myaing, Pokkoku, Burma.* *Missing.

No material from the north-west is available but if westernmost adults really have their wings 114-120 mm. [see Ticehurst *JBNHS* **34**: 468 and Whistler & Kinnear loc. cit. **37**:2881] Blyth's *westermani* needs to be recognised. Biswas supports this view but has unfortunately (*JBNHS* **58**:131) restricted the type locality to Simla, which from the material available appears to be an intermediate area, with larger birds (113, 114) from further eastwards in Kumaon and Darjeeling.

An additional difficulty is a sub-adult plumage in which the males are consistently smaller than the adults.

	Wing	Bill	Tarsus	Tail
4 ad. ♂♂ with rufous on breast,	109,110,113,114	25(2),26,27	19,20(2),21	65(2),69,70
10 sub-ad. ♂♂ excluding 1 Patiala*	104-107 av.105•5	22-26 av.24•5	18-20	62-66 av.64
3 ♂♂ Orissa & A.P.	97,100,104	19,22,24	19(2),21	52,59,66
5 ad. ♀♀	106-114 av. 110•4	22-26 av. 24•4	17-20	62-68 av, 65•6
8 sub-ad. ♀♀	99-106 av. 103•4	22-25 av. 23•6	17-20	57-65 av. 62
1 ♀ Eastern Ghats	104	22	19	60

The adult ♂♂ have a distinct fulvous patch on the breast. This patch is paler in the adult ♀♀ which have duskier underparts and larger bills than the other (? sub-adult) females.

*One ♂ from Patiala (No. 10038) in sub-adult plumage has a 112 mm wing. Two ♂♂ from Dimapur Road, Manipur, 24 October 1946, have yellow streaks on the red of the head, a character not visible in any of the others.

In IND. HANDBOOK **4**:224) *Picus analis* from Java is synonymised with this form. This is not correct for the species does not extend east and south of Hukawng Valley and Bhamo in North Burma.

846 **Picoides macei andamanensis** (Blyth) (Port Blair, Andamans) Andaman Spottedbreasted Pied Woodpecker 4 : 45

10 : 7 ♂♂ 3 ♀♀

1 Landfall Island, North Andamans; 1 Bakultala, Middle Andamans; 3 Wrightmyo, 2 Mithakhari, 1 Pochang, Shoal Bay, 1 Pyinmanala, 1 South Andamans.

Picoides mahrattensis

There has been considerable diversity of opinion regarding the validity of the several races which have been described of this widely distributed species. IND. HANDBOOK (4:226) only accepts the nominate race, but there is no doubt that birds from the north and west are more white on the upperparts and less heavily streaked below. Unfortunately, the names available *aurocristatus* Tickell from Borabhum and Dholbhum and *pallescens* Biswas from Lucknow both fall within the range of the nominate race and cannot be used. Pending examination of more material however I am leaving the northern birds without a name.

847 **Picoides mahrattensis mahrattensis** (Latham) (Mahratta Country) Yellowfronted Pied or Mahratta Woodpecker **4:46**

35 : 19 ♂♂ 16 ♀♀

1 Galkund, Surat Dangs; 2 Nasik, 2 Jubbulpore, 1 Raipur, Melghat, Berar; 1 Murbad Road, 1 Vajreshwari, Thana, 1 Andheri, Salsette, Bombay, 2 Satara, 2 Ratnagiri, Maharashtra; 1 Kadra, 1 Balemani, 2 Karwar, 1 North Kanara; 1 Devon Estate, Hellacuttah, 1 Wadakkancheri, Travancore; 1 Kurumbapatti, Salem Dt., 2 Nallamalai Range; 1 Antagarh, 1 Geedam, 1 Golapalli, 1 Chota Dongur, Bastar, 1 Bhanupratappur, Kanker, 1 Gondia, C.P.; 1 Orissa; 3 Baghownie, Darbhanga, Bihar; 2 Pilibhit Terai.

There is some variation in the intensity of white and/or brown both above and below but this is to some extent affected by the method of preparation. On the west, this form extends up to the Surat Dangs and appears further northwards on the east, extending through the type locality of *aurocristatus* and into Bihar, east of the Ganges.

The measurements do not differ from those of the north-western birds:

	Wing	Bill	Tarsus	Tail
♂♂ nominate	97-104 av.100	23-25 av.24	17-20	55-61 av.59
♂♂ north-western	97-104 av.101	23-25 av.24	15-20	51-62 av.58
♀♀ nominate	95-103 av.99	20-23 av.21	17-19	53-62 av.58
♀♀ north-western	94-106 av.99	20-24 av.22	17-19	52-60 av.57
(IH♂♀	94-110	from skull 21-28	15-21	54-64)

847a **Picoides mahrattensis** subsp. Northern Yellowfronted Pied Woodpecker

25 : 13 ♂♂ 12 ♀♀

1 Campbellpore, 1 Shikohpur, 1 Ladhwa, Karnal, Punjab; 2 Delhi; 2 Bharatpur, 1 Hamavas Lake, 2 Sunda Hills, Jaswantpura, Rajasthan; 1 Radhanpur, 1 Balaram, 1 Deesa, Palanpur, 3 Kharirohar, 1 Bhujia Fort, Kutch, 1 Cambay, 1 Dabka, Baroda, Gujarat; 1 Mathai, Narbada Valley, M.P.; 1 Tirhut, Bihar; 2 Meerut; 1 Netour, 1 Bulandshahr, U.P.

In addition to the differences referred to above, the red on the lower belly is slightly paler than in southern birds.

The three males from Jodhpur State (Nos. 10115, 10117 and 10118)

and another from Dabka, Baroda, (♂ No. 10125) show much more white above and below, the latter accentuated by the white of the chin extending further down the upper breast.

Measurements under 847.

EL **Picoides mahrattensis blanfordi** (Blyth) (Tounghoo, Burma) **4** : 47

1 ♀ Prome.

Wing 102; bill 23; tarsus 19; tail 60.

The single specimen from Burma has the head paler and the underparts more finely streaked than in any of the others. This race was however not based on these characters.

848 **Picoides canicapillus mitchellii** (Malherbe) (Nepal) West Himalayan Greycrowned Pigmy Woodpecker **4** : 50

10 : 5 ♂♂ 5 ♀♀

3 Kalka, 1 Bhagat State, 1 Simla Hills, 1 Simla; 1 Bans, Almora, 1 Kumaon, U.P.; 2 Bhugwada, Nepal.

The black tail, unbarred tail-coverts and tiny streaks of red on the male's nape (as in *Picoides nanus*) separate this group. One of the birds (No. 18544) is marked male, but lacks the red.

The measurements are under 850.

849 **Picoides canicapillus semicoronatus** (Malherbe) (Himalayas, Darjeeling) East Himalayan Greycrowned Pigmy Woodpecker **4** : 49

16 : 9 ♂♂ 7 ♀♀

1 Renchinpong, 3 Singtam, Teesta Valley, 2 Rangpo, 1 Sikkim; 2 Longview, 2 Sevoke, 1 Darjeeling; 2 Kurseong Div., U.P.; 1 Bhutan; 1 Goalpara Dist., Assam.

The ♂♂ can be easily distinguished by the red running right across the nape, with a slight gap at the centre in some. Only one ♀ No. 10149 marked "Sikkim" (C.M. Inglis, no date) has white spots on the central tail feathers. In all, the streaks on the underparts are heavier (broader) than in *mitchellii*. The series from Sikkim (5 ♂♂ 1 ♀) is marked *mitchellii* by Ripley, though this opinion is corrected in IND. HANDBOOK.

Measurements under 850.

849a **Picoides canicapillus** subsp.

11 : 4 ♂♂ (1 by plumage) 4 ♀♀ 3o?

2 Shillong, 2* North Cachar, 1 Samagootling, Naga Hills, Assam; 1* *Kamaing*, 1 *North Kraing*, 1 *Suma, Myitkyina Dist., Upper Burma*, 2 *south-east* (2500′) *and north-east* (1200′) *of Maymyo, North Shan States*, 1* *Loikam, Southern Shan States, Burma.*

There is some little variation among these birds all from south and east of the Brahmaputra. Three males* differ from *semicoronatus* in having very little red restricted to the sides of the nape as in *mitchellii;*

the streaking on the underparts is heavier even than in *semicoronatus*. None have the upper tail-coverts barred or the central tail feathers spotted white as in nominate *canicapillus*. The three from Myitkyina should, according to Biswas (1950, *Proc. Zool. Soc. Bengal* **3**(i), p. 25), be intermediate between *obscurus* (La Touche, S. E. Yunnan) and *omissus* (Rothschild) but they appear no larger than *semicoronatus* and nominate *canicapillus*. In the material available the differences in the characters referred to by Biswas (loc. cit.), i.e. white marks on inner secondaries and barring on back, are not distinguishable.

Measurements under 850.

850 **Picoides canicapillus canicapillus** (Blyth) (Arrakan; type from Ramree Is.) Burmese Greycrowned Pigmy Woodpecker **4** : 51

5 : 3 ♂♂ 2 ♀♀

1 *Kayan Chang, U. Chindwin*; 1 *Kuzeik, Lower Chindwin*; 1 *Chaungri Chaung, Kyankpyu Dist.*, 2 *Kyibu, Henzada Dist., Burma.*

The two from Henzada District lack the rufous wash on the underparts.

All have their uppertail coverts barred and the central tail feathers spotted with white, separating them quite distinctly from the races referred to above. The red on the head is also restricted to the sides as in *mitchellii* and *P. nanus*.

	Wing	Bill	Tarsus	Tail
♂♂				
mitchellii	83-92 av. 88·5	15-16	14-15	39-47 av. 44
	(IH 85-89	17-18	14-15	40-47)
semicoronatus	81-87 av. 85	15-17	14-15	40-45 av. 42
	(IH 80-90	from skull 16-18	13-16	38-46)
849a subsp. ?	82,85,91	*c.* 16	14-15	37,43
(Biswas,-Myitkyina	96-99 av. 97·6	18-18·5	14.5-15	50-52 av. 51)
canicapiltus	82,84,85	15-16	14,15(2)	-, -, 42
	(IH 80-94	from skull 16-19	13-16	34-46)
♀♀				
mitchellii	89-92 av. 90	15-17	14-15	41-45 av. 44
	(IH 84-94	17-18	14-15	42-50)
semicoronatus	82-92 av. 86·5	14-16	14-15	40-44
	(IH 82-91	from skull 16-19	14-15	39-48)
849a subsp ?	82,87,90 (2)	*c.*15	14-16	40 (2), 44
[Biswas, –Myitkyina	98-101	18-19	15-15·5	51-54 (53·2)]
canicapillus	81,83	15 (2)	15,16	40,44 mltg.
	(IH 80-92	from skull 16-19	13-16	39-45, once 49)

The measurements in IND. HANDBOOK are all from Biswas (loc. cit.) and it is not possible to understand how it was determined that some of the measurements of the bill are "from feathers" and others "from skull".

851 **Picoides nanus nanus** (Vigors) (Himalaya) Northern Browncrowned Pigmy Woodpecker 4 : 53

14 : 7 ♂♂ (1 by plumage) 5 ♀♀ 2o?

6 Ambala, Punjab; 1 Dehra Dun, 2 Meerut, 1 Pilibhit, U.P.; 2 Darbhanga, 2 Rajputtee, Saran, Bihar.

Measurements under 852.

852 **Picoides nanus hardwickii** (Jerdon) (Southern India = Goomsoor, Ganjam) Southern Browncrowned Pigmy Woodpecker 4 : 52

26 : 17 ♂♂ 7 ♀♀ 2o?

1 Dohad, 2 Jambughoda, 1 Dediapada, Rajpipla, 1 Waghai, 1 Malegaon, 1 Sarwar, Surat Dangs; 1 Mandu, Dhar State, 1 Raipur, Melghat, Berar; 2 Balemani, 1 Kadra, 1 Gundbola, North Kanara; 1 Chitteri Range, 2 Nallamalai, 1 Anantgiri, Vizagapatnam; 4 Bhanupratappur, Kanker, 1 Basrur, 1 Bhopalapatnam, Bastar, M.P.; 2 Badrama, Barma, 1 Keonjargarh, Orrissa.

In the material available, even in series, this race is barely separable from the nominate, the variation within each group making it impossible to pick out individuals.

Four (2 ♂♂ 2 ♀♀) from Surat Dangs (3) and Dediapada, Rajpipla (1), Gujarat, have their underparts more heavily streaked, though the general effect can be matched in individuals from other places, e.g. ♀ No. 18602 from Badrama, Barma, Orissa. Unsexed No. 10131 from Balemani, North Kanara, has a pale, almost golden head, while that of 10132 (♂ by plumage) from the same place, is as dark as in *cinereigula/gymnopthalmus*.

♂♂	Wing	Bill	Tarsus	Tail
western *nanus*	80,81	15,15	14,14	35,36
eastern *nanus*	75-77 av.76	14 (5)	14 (2), 15 (3)	34-38 av.35·4
	(IH 74-81	from skull 15-17	13-15	35-39)
hardwickii	72-78, one 81 av.74·4	13-14	13-14	31-40 av.34
♀♀	(IH 71-76	from skull 15-17	13-14	33-37)
western *nanus*	80 (2), 81 (2)	15 (3), 16	14 (2), 15 (2)	35,36,39 (2)
eastern *nanus*	75	14	15	36
	(IH 75-81	from skull 14-16	13-15	34-40
hardwickii	73-78 av.75	13-14	13-14	33-38 av.35·5
	(IH 71-77	from skull 15-16	12-13	32-36)

In nominate *nanus* the western birds from the Punjab have slightly but consistently larger wings than those from further east.

853 **Picoides nanus cinereigula** (Malherbe) (Madras = Alleppy, Travancore) Kerala Browncrowned Pigmy Woodpecker 4 : 52

6 ♂♂

1 Fraserpet, Coorg; 1 Coonoor Ghat, 1 Mudumalai, 1 Wynaad, 1 Padagiri, Nelliampathi Hills; 1 Vambayam, Travancore.

Nos. 10179 from Padagiri, Nelliampathi Hills and 10137 from Vambayam, Travancore, resemble Ceylon *gymnopthalmus* in the darkness of the head and absence of streaks on the underparts. They how-

ever agree with other *cinereigula* in size.

Wing 73-77 av. 75 (IH. 71-76); bill 14·3-15·5; tail 32-38 av. 35 (IH. 33-37).

854 **Picoides nanus gymnopthalmus** (Blyth) (Ceylon) Ceylon Browncrowned Pigmy Woodpecker **4 : 54**

1 ♀ Walgama, Ceylon

Wing 65 (IH 74-77); bill 11·3 (14-15 from skull); tail 30 (33-35).

In the single specimen, the measurements are smaller than usually accepted and there is no trace of moult on the wing or tail quills. The underparts are dirty brown and unstreaked as in a male from Vambayam, Travancore, under 853, and which it further resembles in the darkness of the head which separates the latter from *cinereigula*. Jerdon (**1**:479 and **3**:871) placed the Ceylon race in southern India.

855 **Picoides tridactylus funebris** Verreaux (Mountains of Chinese Tibet = Sikang) Yellowcrowned Threetoed Pied Woodpecker

nil.

856 **Hemicircus canente** (Lesson) (Pegu) Heartspotted Woodpecker **4 : 84**

23 : 11♂♂ (2 by plumage) 12 ♀♀ (2 by plumage)

1 Songarh, Navsari, 1 Waghai, 2 Mahal, 1 Sarwar, Surat Dangs; 1 Borivli, Salsette, Bombay; 1 Karwar, 2 Kadra, 1 Balemani, 2 North Kanara; 1 Madumalai Forest, 1 Wynaad, 1 Thattakad, 1 Thekady, 1 Periyar, Kerala; 1 Darba, 2 Barsur, Bastar, M.P.; 1 Badrama, Bamra, Orissa; 1 Bagho Bahar, Cachar; 1 *west of Yomas, Bassein District, Burma.*

Of five with white caps and dark underparts which are presumably characters of young of both sexes, four are females and one unsexed. Specimen No. 10327 from Periyar, dated 23 August, has a white cap and pale underparts but is marked ♂ by the collector, J. P. Cook.

The extent of buffiness on the forehead varies individually, some being almost pure white. In *Bull. B.O.C.* **86**, pp. 162-163 (1966), I have suggested with some evidence that the "creaminess" on the forehead, shoulders and rump of the Pied Imperial Pigeon *Ducula bicolor* (Scopoli) was acquired in the course of preening the base of newly-growing feathers on the rump. I wonder if this "buffiness" which affects other white portions of the plumage on the wings and rump in the woodpecker may not be similarly acquired or be associated with the tuft on the back which secretes a fluid of unknown purpose and utility.

	Wing	Bill
11 ♂♂	93-103 av.96·6	20·5-24 av.22·3
6 ♀♀	91-95 av.93·5	19·6-21·5 av.20·4

There is a small decrease in size southwards and Jerdon's *cordatus* which was described without comparison with the nominate race is now discarded. The 3 largest (and easternmost) specimens from Orissa, Cachar and Burma (wing 100, 103, 98; bill 22·5, 23·5, 24) differ from

the other males in almost completely lacking the tiny white spots on the black forehead, which though varying in extent are always distinctly visible. The male illustrated on plate 52 facing page 208 of Vol. 4 of IND. HANDBOOK shows no speckles on the head.

Incidentally, Jerdon when describing *cordatus* has mixed up the male and the female and refers to the underparts as "dull green" and adds "On the center of the back there is a brush of sap green feathers ....". The green may possibly be due to the use of some preservative, but I must mention that in dry skins, the "tuft" which consists of unbarbed feathers over 20 mm long, lies flat along the back.

EL **Miglyptes jugularis** (Blyth) (Arakan) Black and Buff Woodpecker 4 : 60

2 ♀♀ (1 by plumage) Ataran, Burma.

Wing	Bill	Tarsus	Tail
100,103	19,21	19,19	48,49
(97-107)	(18-20)	(*c.*18-19)	(43-51)

857 **Blythipicus pyrrhotis pyrrhotis** (Hodgson) (Nepal) Red-eared Bay Woodpecker 4 : 55

6 : 4 ♂♂ 2 ♀♀

1 Trepokri, 7500′, 2 between Trepokri and Ghoom, Darjeeling; 1 Laithensew, Khasi Hills, 1 Roopchena, Cachar, 1 Margherita, Assam.

	Wing	Bill	Tarsus	Tail
♂♂	144,144,150,150	41,47 (3)	26,27,28 (2)	81,82,84,86
	(IH 145-153	from skull 48-54	29-30	82-98)
♀♀	141,142	42,47	26,28	78,78
	(IH 137-151	from skull 45-51	-	*c.*82-85

Male No. 10191 from Margherita has a wash of the red of the collar extending on to the upper breast, as also on the upper back. There is variation in the amount of streaking on the head, as also the intensity of the brown on the underparts. In No. 10186 marked "perhaps ♀" collected by Stuart Baker at Laithensew, Khasi Hills, on 18 May 1906, the collar is paler and shows an orange tinge. The upper back is distinctly barred, a character shared with No. 10189, the other female from Darjeeling. This small series suggests that western birds have greyer, less brown, heads than those from Assam.

858 **Chrysocolaptes festivus festivus** (Boddaert) (Goa) Indian Black-backed Woodpecker 4 : 77

5 : 1 ♂ 4 ♀♀

1 Dediapada, Rajpipla, 1 Pimpri, 1 Galkund, Surat Dangs; 1 Chikalda, *c.* 3000′, Berar; 1 Ratnagiri, Maharashtra.

	Wing	Bill	Tarsus	Tail
1 ♂	150	49	29	73
4 ♀♀	149,150 (2), 154	42,44,48 (2)	29,30 (3)	77 (2), 81,82

Two females with the shortest bills and tails, collected at Galkund

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(26 February) and Chikalda (23 January) show traces of red on the yellow crest, which is not visible in the other two (March and October).

859 **Chrysocolaptes festivus tantus** Ripley (Embilipitiya, Ceylon) Ceylon Blackbacked Woodpecker

nil.

860 **Chrysocolaptes lucidus sultaneus** (Hodgson) (Simra, Central Nepal) Western Himalayan Larger Goldenbacked Woodpecker 4 : 80

5 : 4 ♂♂ 1 ♀

1 Baijnath, Almora, 3 Ranibagh, Kumaon, U.P.; 1 Bhugawda, Nepal.

	Wing	Bill	Tarsus	Tail
♂♂	180,184,184,188	49,50,52,52	31,32,32,34	98,99,99,103
	(IH 171-180	from skull 56-62	-	80-100)
♀	184	52	34	98
	(IH 174-180	from skull 53-58	-	98-99)

Biswas's measurements quoted in IND. HANDBOOK relate to birds from Central Nepal. There is a distinct increase in size westwards in the north.

861 **Chrysocolaptes lucidus guttacristatus** (Tickell) (Jungles of Borabhum and Dholbhum) Eastern Larger Goldenbacked Woodpecker 4 : 78

24 : 12 ♂♂ 12 ♀♀

1 Chota Dongar, 1 Basrur, 2 Kameli, Bailadila, Bastar, C.P.; 1 Kutri, 1 Chamundia, Daspalla, 1 Chahala, Simlipal Hills, Orissa; 1 Singtan, Tista Valley, Sikkim; 1 Longview, Darjeeling, 1 Kurseong Division, U.P.; 1 Golaghat, 1 Margherita, Upper Assam, 3 Roopchena, 1 Bagho Bahar, 1 North Cachar; 3 *Taunggyi, South Shan States*; 2 *Prome District*; 1 *Kyiben, Henzada*; 1 *Sandoway District, Burma.*

	Wing	Bill	Tarsus	Tail
♂♂	161-177 av.170·5	46-52 av.48	30-32	85-100 av.93
	(IH 165-172	from skull 48-50	31-33	90-97)
♀♀	162-178 av. 171	45-49 av.47	29-32	85-99
	(IH 168-173	from skull 47-49	31-32	88-90)

The smallest wings are presumably of specimens already measured by Sálim Ali in IND. HANDBOOK, while those over 173 are from Assam and Burma.

862 **Chrysocolaptes lucidus chersonesus** Kloss (Johore, Malaya) Southern Larger Goldenbacked Woodpecker 4 : 80

22 : 12 ♂♂ 10♀♀

1 Mahal, 1 Malegaon, Surat Dangs, Gujarat; 1 near Kasa, Dahanu Taluka, Thana; 1 Funnel Hill, Pen, Kolaba; 1 Satara; 1 Morda, Goa Frontier, 2 Kadra, North Kanara; 1 Linganhally, 1 Jog, Sagar, 1 Billaji, Billigirirangan Hills, Mysore; 1 Munnar, High Range, 1 Parambikulam, Cochin, 3 Kodaikanal, 1 Manalur, 1 Palni Ghats, 1 Perumalmalai, 1 Devanhellucotta, Travancore; 2 Madura, South India.

		Wing	Bill	Tarsus	Tail
♂♂		148-154 av.151	40-47 av.43	28-31	80-87 av.83
	(IH	149-158	from skull 42-52	30-31	77-91)
♀♀		148-155 av.151	40-43 av.41·3	28-31	80-87 av.84
	(IH	147-157	from skull 41-50	27-30	80-89)

The specimens listed above are duller and less yellow than *gutta-cristatus* and the measurements appear exclusive.

It is now customary to accept birds from southern India as of this race and identical with those from Malaya. In the absence of any topotypical material, it is not possible to comment except to draw attention to the fact that *chersonesus* was described for its short 143 mm wing, and the only other specimen referred to also had a 146 mm wing.

8 (5♂♂ 3♀♀) of the 22 specimens have stray tinges of crimson on their backs. There is no evidence of this being a seasonal character.

863 **Chrysocolaptes lucidus stricklandi** (Layard) (Gillymale, Ceylon) Ceylon Crimsonbacked Woodpecker 4 : 81

3 : 1♂ 2♀♀

	Wing	Bill	Tarsus	Tail
♂♀	143,146	41,40	30,29	82,78

One female is in poor condition and has not been measured.

(*to be continued*)

Temperature, salinity and Plankton of Daman Ganga Estuary[1]

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Temperature of air and water of Daman Ganga estuary showed two maxima in a year and the water was warmer than the Arabian sea. A wide range of values of salinity were associated with a wide range of values of biomass of plankton. The values of biomass of plankton of this estuary, at comparable salinity and temperature, were three times less compared to the Mississippi Sound. The values of biomass of plankton in winter were 2.3 times higher compared to the values of biomass of plankton in summer. A plankton calendar was prepared for this estuary for the year 1968-'69. An increase in the number of copepods was associated with an increase in the numbers of phytoplankton. Daman Ganga estuary is a special ecological habitat with warmer water and more numbers of microplankters compared to the adjoining Arabian sea. Warmer waters and abundant microplankton of this estuary are the favourable factors for the survival and rapid growth of planktophagous larvae of euryhaline marine fishes. Thus Daman Ganga estuary, with its special ecological conditions, forms one of the natural factors responsible for the good fish landings of this part of the west coast.

Introduction

Information is not available on the physicochemical and biological conditions of Daman Ganga estuary. Therefore, to find out the factors influencing the abundance of plankton, temperature of air and water, salinity, numbers and dry weights of plankton were studied for a period of 54 weeks. The interrelations of organisms and the influence of hydrographical conditions on the abundance of plankton were studied and compared with other areas.

Field collections were made, always at a fixed area, between 12.00 noon and 1.00 p.m. once in every week. The area of investigation is located at 20°25′ N, 72°50′ E. The width of the river at Daman is

[1] Accepted February 6, 1971.

224 metres excluding the banks. The depth of the river is 6 metres at the lowest low tide level and ten metres at the maximum high tide level.

Methods

Temperature of air and water were recorded in the field using a centigrade mercury thermometer graduated to one tenth of a degree. A sample of water was brought to the laboratory, in a clean glass stoppered bottle and the salinity was measured by Harvey's method (Barnes 1959). Ten ml of sample water was titrated against standard silver nitrate solution using potassium chromate as indicator. The necessary correction, as given by Harvey, was made. Three titrations were made and the average values are presented. Plankton collections were made concurrently with the hydrographical studies. Plankton was collected with half metre tow net made of best Swiss organdy. The net was towed by boat for 5 minutes across the river from bank to bank. Thus, a cross section of nearly 37 (36.83) cubic metres of water was filtered by the net, as a distance of 190 metres was constantly covered, in 5 minutes. The plankton collections were transferred to a pneumatic trough and the plankters were examined in fresh condition in the laboratory. The debris and other foreign materials were carefully handpicked. The plankton was then filtered with the organdy and was washed in to 5% formalin kept in an enamel tray. Later the plankton was transferred in to a bottle. Macro-plankton and nekton were separated and 1 ml of sample was diluted to a constant volume. From this diluted sample 1 ml was taken in to a Sedgwick Rafter cell and the numbers of plankters were counted under a microscope. Six counts were made for each plankton sample and the average numbers of organisms are presented. Later the plankton was filtered using Whatman No. 42 filter paper (Graham 1943) and dried in a hot air oven at 60°C to constant weight. The average values for each month are presented.

Results

(1) Temperature:

The results of air temperature are presented (Table 1). The temperature maxima (35.2°C) was recorded on 7-iv-1969. The temperature minima (22.8°C) was recorded on 4-i-1969. The submaximum temperature (35°C) was recorded on 30-ix-1969 and also in the first two weeks and fourth week of October, 1969. The amplitude of annual variation of daily temperatures was 12.4°C. The amplitude of variation of mean monthly temperatures was 7.44°C. The mean

monthly temperature showed two maxima one in April and the other in October.

TABLE 1

TEMPERATURE OF DAMAN GANGA ESTUARY DURING 1968-'69

Month & Year	Temperature of Air °C Range	Temperature of Air °C Average	Temperature of Water °C Range	Temperature of Water °C Average
Nov. 1968	30.0-34.40	32.14	27.0-30.0	28.16
Dec.	29.4-32.00	31.00	25.2-28.4	26.60
Jan. 1969	22.8-30.00	26.60	22.0-25.6	24.08
Feb.	27.0-33.10	29.27	25.0-26.4	25.70
Mar.	28.9-32.80	30.58	27.0-31.0	29.10
Apr.	31.4-35.20	33.20	31.4-32.9	32.17
May	32.0-33.20	32.65	32.0-33.0	32.65
June	28.8-32.40	30.65	29.0-32.2	31.25
July	29.4-31.20	30.56	29.0-32.2	30.44
Aug.	29.4-32.80	30.55	28.6-31.9	30.07
Sep.	27.0-35.00	30.08	26.6-33.2	29.60
Oct.	30.4-35.00	34.04	29.8-31.8	30.72

The results of water temperature are also presented in Table 1. The temperature showed variation in each month. Maximum temperature (33.2°C) was recorded on 30-ix-1969 and minimum (22.0°C) was recorded on 1-i-1969 and on 4-i-1969. The amplitude of annual variation of daily temperature was 11.2°C. The amplitude of annual variation of mean monthly temperatures was 8.57°C. The temperature of water showed two maxima which were recorded in May and October, 1969. The air and water temperatures of this estuary showed two maxima in the year.

In Daman Ganga estuary mean monthly water temperatures ranged from 24.08°C to 32.65°C. Chacko & Ganapati (1949) recorded highest temperatures in April and May and lowest temperatures during December and January with an annual range of 22.0° - 35.0°C in Adayar estuary. Ganapati & Murthy (1955) reported three peaks in temperature in October, March and June and three depressions in January, April and August with an annual range of monthly mean temperature of 4.4°C in the sea off Visakhapatnam coast. Bose (1956) reported a temperature range of 18.0 - 33.0°C in Hooghly estuary. The temperatures of the water of this estuary are higher compared to the sea water temperatures of Arabian sea off this estuary at 20°N and 21°N (Jayaraman & Gogate 1957) by 2.3°C (December), 1.58°C (January), 2.2°C (February) and 3.6°C (March). Ganapati & Sarma (1958) recorded a variation of temperature of 24.33 - 29.9°C in sea at Waltair with two peaks in June and September (1953-1954) and June and October (1954-1955). Subrahmanyan (1960a) recorded at Calicut

25.3°C (July) and 30.0°C (April). But in this estuary 30.44°C and 32.17°C were recorded in the respective months thereby indicating that the temperature of the estuarine waters of Daman Ganga were 5.14°C and 2.17°C higher compared to sea water at Calicut. The occurrence of two peaks was reported for all the warmer areas in and around India by several workers (Sitaramaiah 1966b). Durve & Bal (1961) reported lowest temperatures during November-December and highest temperatures during April-May in backwater and sea water respectively near Bombay. Panikkar & Jayaraman (1966) have reported 27-29°C in Bay of Bengal and 23-29°C in Arabian sea. Qasim *et al.* (1969) recorded 28-31°C in a tropical estuary.

The temperatures of Daman Ganga estuary were higher by a minimum of 1.58°C (January) and ranged to a maximum of 5.14°C (July) compared to the adjacent Arabian sea. Malhotra *et al.* (1970) reported higher percentage (25-80% and 15-30%) of hatching of fertilized eggs of *Hilsa ilisha* at higher temperature ranges (25.5 - 30.4°C and 26.8 - 28.4°C) and low percentage (5-20% except in one case of 70%) at lower range of temperatures (24.8-27.1°C). Thus, it is clear that with its warmer water Daman Ganga estuary forms a good breeding ground for the fishes to spawn (Table 5) and a natural nursery for the hatching and development of eggs of euryhaline fishes.

(2) **Salinity:**

The results of salinity are presented in Table 2. The salinity of this estuary varied from 0.36‰ (on 17-vii-1969 and on 24-vii-1969) to 34.3‰ (on 18-i-1969). During the period November 1968 through June 1969 the mean monthly salinities varied from 28.62‰ to 33.27‰. The amplitude of annual variation of mean monthly salinities was 31.92‰. During the period July 1969 to October 1969 the mean monthly salinities varied from 1.35‰ to 19.82‰. Thus, the salinities of this estuary touch both the extremes with two distinct and widely separated ranges. The high and low salinities of this estuary were due to the maximum influx of sea water into the estuary and the rainfall in the upper reaches of the river respectively.

Ganapati & Murthy (1955) reported minimum salinity in November in the sea at Visakhapatnam while in this study the mean monthly minima was recorded in August. Bose (1956) reported a salinity range of 1.6‰ to 30.0‰ in Hooghly estuary. In the present study highest salinity was recorded in January (34.3‰) and the mean monthly maxima was recorded in February 1969, while Ganapati & Sarma (1958) recorded, maxima in April, in the sea off Waltair coast. Jayaraman & Gogate (1957) have recorded, off this estuary in Arabian sea, at 20°N, a salinity of 32.65‰ (November) to 36.02‰ (December to May) and at 21°N salinity of 36.45‰ (June), 36.76‰ (August), 33.55‰ (November) and 36.0‰ (May). Ramamoorthy's (1953b)

TABLE 2

TIDE, COLOUR OF WATER AND SALINITY OF DAMAN GANGA ESTUARY DURING 1968-'69

Month & Year	Tide	Colour of water	Salinity ‰ Range	Average	Remarks
Nov. 1968	HHHHL	Blue	26.34-33.50	30.31	
Dec.	HHHL	Brownish green	27.22-31.65	29.81	Bloom
Jan. 1969	HHHLL	Blue	16.23-34.30	28.62	Bloom
Feb.	HHLL	Blue	32.70-33.50	33.27	
Mar.	HHHLL	Blue	30.18-33.50	32.05	
Apr.	HHHL	Blue	30.51-33.30	32.05	Bloom
May	HHHH	Blue	31.58-31.11	31.71	Bloom
Jun.	HHHL	Blue	26.72-31.15	29.64	
July	HHHLL	Muddy brown	00.36-07.36	02.37	
Aug.	HHHL	Muddy brown	00.90-02.70	01.35	
Sep.	HHHLL	Muddy brown	00.72-08.52	03.92	Bloom
Oct.	HHHLL	Blue	06.70-27.78	19.82	

results of Madras coast are similar to those of Jayaraman (Subrahmanyan 1960a) and vary between 23.23‰ to 34.94‰. Panikkar & Jayaraman (1966) have reported 30.33‰ in Bay of Bengal and 34.37‰ in Arabian sea. Qasim *et al.* (1969) recorded 2.2‰ in a tropical estuary.

(3) **Biomass of Plankton:**

The results of dry weights of plankton are presented in Table 3. The dry weights of plankton varied from 0.001 to 16.575 gm. The values of biomass closely followed the salinity values. A salinity range of 0.36‰ to 8.52‰ from 3-vii-1969 to 7-x-1969 was associated with an average biomass of plankton of 0.063 gm for 5 minutes per collection. The total number of plankters was also very low in the very low salinity range (Tables 3 & 4). A salinity range of 23.93‰ to 34.3‰ (except 16.23‰ on 25-i-1969 and 13.71‰ on 18-x-1969) from 2-xi-1968 to 28-vi-1969 and from 11-x-1969 to 31-x-1969 was associated with an average biomass of plankton of 0.796 gm for 5 minutes per collection. The biomass of plankton at low salinity was twelve and half times less compared to the biomass values of plankton at high salinity ranges. The ranges of temperatures, corresponding to the higher and lower salinity ranges, were 22.0-33.0°C and 26.6 to 33.2°C respectively.

Sitaramaiah (1967a) reported rich amounts of plankton, nekton and shrimps at higher salinity ranges in Mississippi Sound. In Mississippi Sound a high salinity range of 18.02‰ to 27.75‰ at Deer Island station and a low salinity range of 12.9‰ to 24.0‰ at station 28 were associated with an average production of plankton of 2.423 gm and 2.371 gm for 5 minutes per collection respectively. In Mississippi

TABLE 3

NUMBERS AND DRY WEIGHTS OF PLANKTON OF DAMAN GANGA ESTUARY DURING 1968-'69

Month & Year	Number/5 Minutes Thousands Range	Average	Dry Weights/5 Minutes gm Range	Average
Nov. 1968	0.368-37.09	8.699	0.002-0.037	0.014
Dec.	4.682-138000	34542.83	0.001-2.39	0.62
Jan. 1969	7.034-327.291	80.443	0.02 -0.25	0.074
Feb.	0.341-25.893	7.981	0.001-1.435	0.394
Mar.	0.14 -95.788	29.075	0.001-0.86	0.245
Apr.	0.313-476.8	122.979	0.11 -0.34	0.207
May	5.718-3629.3	1612.25	0.18 -3.065	1.446
Jun.	0.011-14.5	6.823	0.001-1.36	0.399
Jul.	0.003-3.192	0.7	0.001-0.655	0.132
Aug.	0.001-0.31	0.119	0.001-0.11	0.028
Sep.	2.643-1592.43	319.66	0.005-0.215	0.045
Oct.	0.842-120.14	41.953	0.05 -16.58	3.431

Sound the ranges of temperature corresponding to the low and high salinity ranges were 28.7-31.4°C and 27.0-32.5°C respectively. Average biomass values of plankton of Daman Ganga estuary during higher salinity ranges and at almost identical temperature ranges were three times less compared to Mississippi Sound. The results of the present study and those of Mississippi Sound clearly show that the greater the amplitude of variation of salinity the greater is the range of variation of dry weights of plankton.

TABLE 4

NUMBERS OF PHYTOPLANKTON AND COPEPODS OF DAMAN GANGA ESTUARY DURING 1968-'69

Month & Year	Phytoplankton/ 5 Minutes Thousands Range	Average	Copepods/5 Minutes Thousands Range	Average
Nov. 1968	0.355-2.89	0.649	0.219-18.88	4.344
Dec.	3.465-138158.82	34539.7	0.201- 8.25	2.395
Jan. 1969	2.964-317.2	76.147	0.704-7.106	3.309
Feb.	0.256-2.75	1.059	0.011-5.915	1.537
Mar.	0.14 -16.0	5.958	0.105-12.0	2.421
Apr.	10.14-473.0	121.78	0.003-2.262	1.149
May	519.0-3561.2	1567.8	5.632-74.75	34.955
Jun.	0.0 -0.23	0.057	0.003-12.42	3.676
Jul.	0.0 -0.466	0.093	0.288- 2.1	0.477
Aug.	0.0 -0.064	0.016	0.084-0.194	0.069
Sep.	1.761-1229.85	246.79	0.566-362.5	72.798
Oct.	0.708-4.833	2.508	0.134-80.0	21.206

The winter (October to March) biomass of plankton (0.817 gm for 5 minutes per collection) of this estuary was 2.3 times higher compared to the summer (April to September) biomass of plankton (0.35 gm for 5 minutes per collection). The temperature ranges of winter and summer were 22.0.-31.8°C and 26.6-33.2°C respectively. The low summer values of biomass of plankton were associated with very low salinity range of 0.36-8.52‰ during July, August and September. In order to eliminate the low salinity factor, the biomass of plankton for summer was calculated for the period April, May and June and compared with the winter values. The summer value under comparable salinity conditions was 0.684 gm for 5 minutes per collection. Thus, the low values of biomass of plankton of this estuary were associated with low salinity and high temperature ranges of July, August and September. The average value for summer after eliminating the low salinity factor (0.684 gm for 5 minutes per collection) was still lower than the winter value (0.817 gm for 5 minutes per collection). The low summer values may be partly due to higher ranges of temperatures (26.6-33.2°C) of summer. It is well known that the higher temperatures enhance the respiratory rates of organisms and cause greater loss of energy (Sitaramaiah 1967b & 1966a).

Table 5

Young and adult fishes contained in the plankton collections of Daman Ganga estuary during 1968-'69

Species	Size Range in cm Total length	Total number
Hilsa ilisha	0.3-4.8	70
Engraulis dussumieri	0.3-6.4	156
Scianid fish larvae	0.2-1.2	99
Gobid fish larvae	0.5-2.1	8
Leptocephali larvae of eels	2.9-3.3	8
Syngnathus spicifer	5.5	1
Belone strongylurus	21.6	1
Fish eggs		1268
Crustacea		
Palaemon lamarrii		7
Post larval shrimps		68

The total number of young and adult fishes and prawns contained in the plankton collections are represented in Table 5. Inspite of the fact that the tow net is not the proper net to collect fish and fish larvae, considerable number of young, adult fishes and prawns were collected in the tow net which was operated only in the surface layer of half metre of water column. The total number of fish eggs contained in the

plankton collections was 1268. Of the 1268 fish eggs collected during the year 96 per cent were collected during the period November, 1968 to April, 1969. The occurrence of the fish eggs in the plankton collections clearly indicates that the fishes spawn either in the estuary or in the vicinity of this estuary. A plankton calendar was prepared for this estuary and is presented in Table 6.

TABLE 6

PLANKTON CALENDAR OF DAMAN GANGA ESTUARY FOR THE YEAR 1968-'69

NAME	N	D	J	F	M	A	M	J	J	A	S	O
1. *Spirogyra*	—	—	—	—	—	—	—	—	—	—	A	—
2. Cladocera	—	—	—	—	—	—	—	—	—	R	—	—
3. *Palaemon lamarrii*	—	—	—	—	—	—	—	—	R	R	—	R
4. *Syncdra*	—	A	—	—	—	—	—	—	—	—	—	—
5. *Ntzchia*	—	A	—	—	—	—	—	—	—	—	—	—
6. *Cylendrotheca gracilis*	—	B	A	—	—	—	—	—	—	—	—	—
7. *Coscinodiscus*	C	A	A	C	A	B	B	R	R	R	B	A
8. Copepods	A	A	A	A	A	A	A	A	C	R	A	A
9. Crustacean eggs	—	—	—	C	—	—	—	—	—	—	—	A
10. Nauplius larvae	—	—	C	R	A	—	—	—	—	—	—	—
11. Metanauplius larvae	C	R	—	R	—	—	—	—	—	—	—	A
12. Zoea larva of prawn	R	C	C	R	A	C	—	—	—	—	—	—
13. Zoea larva of Crab	A	R	C	C	R	—	A	—	—	R	—	A
14. Megalopa larva	—	—	—	R	—	R	R	R	R	R	—	R
15. Mysidacea	R	C	C	A	A	C	A	A	R	—	R	A
16. Post larval shrimps	—	R	R	R	R	R	R	R	—	—	—	—
17. Chaetognatha	—	R	R	R	R	R	C	R	—	—	R	R
18. Fish eggs	R	R	R	R	R	R	R	R	—	R	—	R
19. *Hilsa ilisha*	R	—	—	—	—	—	—	—	R	—	—	R
20. *Engraulis dussumieri*	—	R	R	R	R	R	R	R	R	—	—	—
21. *Belone strongylurus*	—	—	—	—	—	—	—	—	R	—	—	—
22. *Syngnathus spicifer*	—	—	—	R	—	—	—	—	—	—	—	—
23. Leptocephali larvae of eels	—	—	—	—	—	—	—	—	R	—	R	—
24. Gobid fishes	—	—	—	—	—	—	—	R	R	—	—	—
25. Scianid larvae	R	R	R	—	R	—	R	R	R	—	—	R
26. Coelenterate medusae	—	—	R	R	C	R	R	R	—	—	—	—
27. *Beroe cucumis*	R	R	R	R	R	R	—	—	—	—	—	—
28. *Pleurobrachia*	—	R	R	—	R	R	—	—	—	—	—	—
29. *Salpa*	—	R	R	—	—	R	R	—	—	—	—	—
30. *Doliolum*	R	R	R	—	R	—	—	—	—	—	—	—

Rare : R : 1-100/5 minutes
Common : C : 101-1000/5 minutes
Abundant : A : 1001-100,000/5 minutes
Swarms : S : Above 100,000/5 minutes
Blooms : B :

The dry weight of biomass of plankton increased with increase in salinity (Table 7) in the estuary, towards the sea, thereby, clearly showing the existence of large sized adults of marine plankters at higher

salinities. The numbers of eggs, young ones, diatoms and copepods were more abundant in the estuarine side at lower salinities, probably because of the presence of less numbers of plankton predators like chaetognath (Table 7) which were present in more numbers in higher salinities. Thus, the rich microplankters (copepods, diatoms, crustacean eggs, zoea larvae of crabs and metanauplii) form food to the planktophagous larvae and young ones of *Hilsa ilisha* and other fishes. The major food of young *Hilsa ilisha* consists of crustacea and diatoms (Halder 1968). Excluding the sand, more than 50 per cent of the gut contents of young *Hilsa ilisha* consist of only diatoms and crustacea (Halder 1968). Furthermore, the low salinity estuarine areas could not be penetrated by the stenohaline marine plankton feeders. Thus, the euryhaline planktophagous fish larvae find more advantage in terms of abundance of food, especially, in the absence of marine stenohaline planktophagous competitors. Special ecological habitats of this nature are the natural factors that are responsible for the greater yield of west coast fisheries. Further studies are needed.

TABLE 7

DISTRIBUTION OF PLANKTON IN RELATION TO SALINITY IN DAMAN GANGA ESTUARY IN THE AREA OF CONFLUENCE ON 30-X-1969 BETWEEN 8.00 AND 13.00 HRS.

1.	Salinity ‰			20.24	27.87	29.81
2.	Dry weight of plankton: Gm/5 Minutes			0.285	0.525	0.571
3.	Crustacean eggs: Thousands/5 Minutes			4.6	—	—
4.	Fish eggs	,,	,,	0.116	0.188	—
5.	Zoea larvae of crabs	,,	,,	4.0	1.771	0.009
6.	Copepods	,,	,,	452.5	350.5	106.65
7.	*Coscinodiscus*	,,	,,	25.4	77.4	14.35
8.	Metanauplius larvae	,,	,,	12.25	16.23	0.683
9.	Mysidacea	,,	,,	0.602	0.293	0.004
10.	Chaetognatha	,,	,,	0.005	0.072	0.428
11.	*Beroe cucumis*	,,	,,	—	0.003	0.025

(4) **Phytoplankton:**

The numbers of phytoplankton varied from 0.016 to 34539.7 thousands for 5 minutes per collection (Table 4). Phytoplankton "Blooms" were recorded in the months of December 1968, January, April, May and September 1969. The phytoplankton maxima and submaxima were recorded in December 1968 and May 1969 respectively. Ganapati & Murthy (1956) reported two maxima one in November and the other in April in the bay of Bengal off Waltair coast. Primary maxima of phytoplankton production was reported in the east coast, in February at Waltair, in March at Madras, in June at Krusadai and in the west coast, during January to May at Trivandrum, May to September at Calicut, September to February at Bombay (Ganapati & Murthy 1956).

Subrahmanyan (1960b) recorded maximum standing crop in May-September-October attaining peak in July, minimum in November and with one or more pulses of production. In this study, the diatoms constituted the bulk of the phytoplankton. The total number of zooplankters increased with increase of diatoms. Similar observations have been made earlier (Subrahmanyan 1960b).

(5) **Copepods:**

The numbers of copepods varied from 0.069-362.5 thousands for 5 minutes per collection during November 1968 to October 1969 (Table 4). The mean monthly maxima and submaxima of copepods were recorded in September and May 1969 respectively. The results of this study showed peak numbers of copepods associated with peak numbers of phytoplankton or preceded by large numbers of phytoplankters. On 18-i-1969 a "Bloom" of phytoplankton was associated with large numbers of copepods. During May 1969 the copepods maxima was preceded by peak numbers of phytoplankton. An increase in numbers of copepods on 1-i-1969 was preceded by large numbers of phytoplankton. Thus, the general statement that the appearance of phytoplankton will be succeeded by zooplankton holds good in this estuary. Similar observations have been made earlier in the sea off Waltair coast (Ganapati & Sarma 1958).

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Food of *Rana tigerina* (Daud.)[1]

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The Indian Bull-Frog, *Rana tigerina* (Daud.) is a widely distributed, important frog of India. A common species in fields under wet cultivation, its insectivorous habit helps in no small way, in eradicating agricultural and other pests. However, as the frog is edible, its heavy commercial exploitation has resulted in considerable depletion of its number and as such its present status is a cause for concern. This study is an effort directed not only towards collecting data on the natural diet of the frog but also towards determining the role it plays in the economy of nature.

Earlier literature on the food of *R. tigerina* includes papers, among many others, by Gostling (1895), Chibber (1911), Agharkar (1912), Mullan (1912), Davidson (1916) and Zutshi (1926) but most of these refer to observations on unusual rather than the normal food of the species. Wadekar (1963) listed the different food items of the frog while attempting to correlate the diet with their availability during different months of the year. Joshee (1968) examined the stomach contents of 100 frogs that were brought to the laboratory for dissection.

MATERIALS AND METHODS

The stomach contents of 347 frogs, collected between September 1970 to August 1971 were examined. The majority were captured during the early morning hours, from paddy fields near Bombay. The specimens were brought to the laboratory, their snout to vent length and weight were recorded and the stomachs removed and preserved in 10 per cent formalin for subsequent detailed examination of their contents. Different food items from individual stomachs were identified as far as possible and their numbers, weight and economic importance, if any, noted. The available data was then tabulated monthwise and also in relation to the size of the specimens with 20 mm gradation. Frogs

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below the size of 50 mm were not considered because the food in their stomachs, besides being scanty, was difficult to analyse.

Food of *Rana tigerina*

Table 1, gives monthwise analysis of the different food items consumed by *R. tigerina*. It indicates that insects and crabs form its main diet almost throughout the year in the Bombay area. A brief account of the various food items recorded during the study is given below.

Annelids and Molluscs:

Though a few earthworms and gastropods were recovered from the stomachs of a few small sized individuals, there is no reason to believe that they form regular items of the diet.

Arthropod:

Anthropods as represented by insects and crabs from the bulk of the diet of *R. tigerina*. An insignificant number of centipedes and arachnids were also recorded from the stomachs of a few specimens.

Amongst the arthropods, insects appear to be most favoured diet of this animal. As many as forty-one species of insects belonging to ten different orders were recovered from their stomachs. There is, however, no indication to show their particular preference for any of these species. Since a number of orthopteran and coleopteran species are available during major part of the year, the representatives of these two orders naturally form the bulk of their insect diet. A number of these insects are of significant economic importance. Table 2 gives the status of the various insects fed on by the frog. Thirteen among these are important agricultural pests, four house-hold pests and four others are injurious to trees. As an indiscriminate feeder, the frog feeds on some harmless or even some of the directly or indirectly useful insects, but this does not in any way affect the important role it plays in the biological control of insect pests.

Crabs are next in importance to insects in the diet of *R. tigerina*. These crustaceans which are often seen in the paddy-fields cause considerable damage to the bunds in the fields by boring holes in them. In addition, they also damage the paddy crop during the flowering season of the paddy (McCann 1932, Jabir Ali 1955). The frog thus keeps in check the population of yet another group of animals harmful to agriculture. The occurrence of *Varuna litterata*—an estuarine crab in the stomachs of a few individuals was thought to be rather unusual. However, observations on the feeding habits of this crab revealed that it often invades the adjoining paddy fields for its food and is taken by the frog during such visits. The largest of the crabs consumed weighed 27 gm.

Vertebrates:

Representatives of all the vertebrate groups were recovered from the stomachs of a number of frogs, but they do not appear to form a part of the regular diet of the frog. However, it may be mentioned that cannibalism is quite common in *R. tigerina*. On one occasion a frog measuring 175 mm in length was seen devouring another frog of the same species measuring 110 mm. It seems that individuals of other species of anurans are also taken.

Miscellaneous:

In addition to these varied food items extraneous material like vegetable matter and gravel was often seen in the stomachs of a number of individuals. Most of the vegetable matter was, however, also seen in an undigested condition in the rectum, suggesting thereby that this material is not digested by them and as such cannot be considered as forming part of their food. The frequent occurrence of gravel in the stomachs of frogs is reported by a number of workers. During the course of the present investigation an individual was seen with as many as seven small pieces of stones weighing totally about 19 gm. It is not known whether gravel is swallowed intentionally. It seems more likely that the gravel as also the vegetable matter is taken up by the animal, accidentally, along with food.

Table 3 gives the various food items consumed by different 20 mm size groups of *R. tigerina*. It is evident that whereas insects and crabs form the main diet of all the different size groups, annelids and molluscs are consumed by small sized and vertebrates by the bigger frogs. It can, therefore, be surmised that insects and crabs constitute the main food of this frog.

The available facts thus indicate that *R. tigerina* plays a very significant role in controlling agricultural and other pests in the field and thus plays a very important role in the economy of nature.

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TABLE 1

MONTHWISE ANALYSIS OF THE STOMACH CONTENTS OF *R. tigerina* (DAUD.)

Number of the individual food items collected/number of stomachs from which collected.

Classified food items	Months Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Remarks
ANNELIDA													
(Earthworms)													
Pheritima sp.	2/2	—	—	—	—	—	—	—	—	2/1	3/1	—	
MOLLUSCA													
Ariophanta sp.	1/1	—	—	1/1	1/1	—	—	—	2/2	—	—	—	Shells found in un-
Planorbis sp.	—	—	—	1/1	—	—	—	—	2/2	—	—	—	digested condition.
Pila virens	—	—	—	—	—	—	—	—	2/1	—	1/1	—	
ARTHROPODA													
Class *Insecta*													
Order ODONATA	—	—	—	4/2	2/1	—	—	—	—	2/2	—	—	
(sp. not identified)													
Order ORTHOPTERA													
Family Gryllidae													
Gryllotalpa africana	4/2	2/2	—	—	—	—	—	—	—	1/1	2/1	—	Pest on paddy.
Gryllotalpa sp.	5/2	23/4	6/4	2/1	6/2	—	3/1	—	1/1	10/4	4/2	3/2	Pest on paddy.
Schizodactylus monstruosus	—	—	—	1/1	—	2/1	—	2/2	—	1/1	—	—	
Brachytrypes sp.	5/2	2/1	4/1	—	—	—	2/1	—	2/1	3/3	2/1	—	Injurious to seedlings.

TABLE 1 (Continued)

Classified food items	Months Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Remarks
Family Tettigoniidae													
Holochlora albida	3/2	2/2	2/2	1/1	—	—	—	1/1	—	3/2	2/2	1/1	Economically not important.
Callimenelus opacus	1/1	—	—	—	1/1	2/1	—	—	—	—	2/1	—	— do —
Mecopoda elongata	—	—	3/2	6/4	1/1	—	—	—	—	—	—	1/1	Appear in Oct.-Nov., feed on leaves of trees.
Family Acridiidae													
Hieroglyphus banian	5/2	7/3	1/1	1/1	—	—	—	—	2/1	3/2	9/2	1/1	Very harmful to rice.
Parella sp.	2/2	3/1	—	1/1	2/1	—	—	1/1	2/1	4/4	—	6/2	Harmful for low growing plants.
Scelimena sp.	3/2	7/5	3/2	4/2	2/2	6/1	—	—	4/1	2/1	—	2/2	Harmful to crops in marshy places.
Order DERMAPTERA													
Family Labiduridae													
Labidura riparia (Earwigs)	1/2	2/2	2/2	2/2	1/1	4/4	2/2	2/1	2/1	3/2	3/3	2/1	Carnivorous, eats small insects.
Order BLATTIDAE													
Cockroach	2/1	—	1/1	2/1	—	—	—	—	3/2	3/1	—	—	Household pest.
Order ISOPTERA													
Termites	—	15/4	—	—	—	—	—	—	—	**/5	15/1	7/2	Household pest. (** several)

TABLE 1 (Continued)

Classified food items	Months: Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Remarks
Order RHYNCHOTA													
Family Corixidae													
Corixa sp.	8/2	6/1	—	—	—	—	—	—	—	4/1	—	4/2	Bug; plant sucker.
Family Belostomatidae													
Belostoma indica	3/3	1/1	2/2	—	—	1/1	—	—	—	2/2	2/2	2/1	Carnivorous water bug.
Sphaerodema sp.	3/2	—	1/1	3/2	—	—	—	—	—	3/3	2/1	—	Carnivorous water bug.
Family Nepidae													
Laccotrephes ruber	3/2	2/1	1/1	—	—	2/1	—	—	2/2	3/2	2/1	3/2	Lives in water and is predacious on other water insects and other animals.
Order LEPIDOPTERA													
Heterocera	—	3/2	9/5	2/2	—	—	—	7/3	—	2/1	7/2	2/1	Larvae and adult.
Order DIPTERA													
Family Syrphidae													
Eristalis sp.	—	—	3/1	—	12/9	22/10	—	10/4	—	1/1	—	2/1	
Family Muscidae													
Musca sp. (House Fly)	—	—	1/1	—	—	—	—	—	—	15/1	—	2/1	Household pest.

TABLE 1 (Continued)

Classified food items	Months Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Remarks
Order HYMENOPTERA													
Family Eumenidae (Wasp)													
Rhynchium sp.	—	2/2	—	—	—	3/2	—	—	1/1	—	—	—	
Family Formicidae (Ants)													
Camponotus compressus	6/5	—	4/3	4/2	—	2/1	—	—	1/1	—	7/4	4/4	
Solenopsis geminata	16/2	—	3/1	—	—	3/1	—	—	5/1	8/2	3/1	1/1	
Aphaenogaster beccarii	—	—	15/1	—	3/2	—	5/2	20/2	—	—	2/1	—	
Oecophylla smaragdina	—	—	—	—	—	4/1	—	—	—	11/1	6/2	—	A nuisance on trees, weaving leaves together. Collects small insects.
Family Apidae													
Apis dorsata	1/1	—	—	—	—	—	—	—	—	—	—	2/1	Economically useful.
Order COLEOPTERA													
Family Cicindelidae													
Pherosophus sp.	1/1	2/1	2/2	—	—	1/1	—	—	—	—	2/2	1/1	Tiger beetles. Carnivorous adults and larvae eat insects.
Family Carabidae													
Ophanus indicus	—	2/2	1/1	—	—	—	1/1	—	—	4/2	—	2/1	Ground beetle. Generally a scavenger. Larvae may harm roots of plants.

TABLE 1 (Continued)

Classified food items	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Remarks
Harpalus sp.	—	4/1	3/1	—	2/1	—	—	—	—	5/2	12/2	3/1	
Family Dytiscidae													
Cybister sp.	—	2/2	—	1/1	3/2	—	1/1	—	—	2/1	3/2	—	Carnivorous water beetle.
Family Hydrophilidae													
Stethoxus sp.	2/2	4/2	4/3	2/1	1/1	—	—	—	—	3/2	—	2/2	Larvae in water and carnivorous.
Family Scarabaeidae													
Catharsius molossus	1/1	2/1	—	2/1	—	—	—	1/1	—	—	2/1	2/1	Dung roller.
Anomala elata	2/2	4/2	8/3	3/2	2/1	—	12/4	—	2/1	13/9	—	16/6	Larvae destroys roots of trees, adults feed on plant leaves. Harmful to agriculture.
Anomala bengalensis	3/2	1/1	2/2	—	1/1	3/2	5/4	1/1	2/2	—	2/2	4/2	Harmful to roots in larval stages. Feeds on leaves as adult.
Onitis sp.	1/1	2/1	—	—	—	—	—	—	1/1	—	1/1	—	Beetles not particularly harmful, scavengers.
Family Elateridae Unidentified	2/1	4/2	1/1	—	2/1	—	—	4/1	—	2/1	3/2	4/1	Generally predators.

TABLE 1 (Continued)

Classified food items	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Remarks
	Months												
Family Tenebrionidae *Pseudoblaps* sp.	1/1	2/2	—	4/2	—	—	—	2/1	—	2/2	—	2/1	Beetles not of economic importance.
Family Cerambycidae *Priotyrannus mordax*	3/1	1/1	2/2	—	—	—	—	3/2	2/1	—	4/1	2/1	Lives in forest areas feeding on dead material.
Batocera sp.	2/1	3/2	4/2	6/2	5/2	—	—	2/1	8/3	4/1	2/1	6/2	Harmful borer.
Family Chrysomelidae Unidentified	2/1	12/2	—	13/2	—	4/1	—	—	1/1	7/5	16/1	8/4	Harmful to leaves of plants. Found in large numbers.
Class ARACHNIDAE Spiders (*Aranae*)	1/1	2/1	—	—	3/2	—	—	1/1	4/2	*66/1	—	—	* All specimens (except one) were young spiders.
Centipedes	—	1/1	—	—	—	—	—	—	—	—	1/1	—	
Scorpions	—	—	1/1	—	—	—	1/1	—	—	—	1/1	—	
Class CRUSTACEA *Paratelphusa guerini*	6/6	7/5	5/4	3/3	4/2	4/4	3/2	—	—	6/3	7/5	9/7	Common in paddy fields and pest of crops.

TABLE 1 (Continued)

Classified food items	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Remarks
Paratelphusa jacquemontii	4/3	3/2	2/2	3/1	2/2	—	—	1/1	—	3/3	2/1	3/2	Noticed more in the monsoon season when it comes out of the burrows. This is also their breeding season.
Gecarcinucus jacquemontii	2/1	1/1	—	1/1	2/2	—	—	1/1	1/1	2/1	1/1	2/2	This damages bunds by burrowing.
Varuna litterata	2/2	3/2	1/1	—	2/2	—	—	3/3	—	2/1	1/1	—	An esturine crab.
VERTEBRATE													
Class PISCES													
Heteropneustes fossilis	1/1	—	1/1	—	—	—	—	—	—	—	1/1	—	84-85 mm in length.
Rasbora daniconius	—	1/1	—	—	—	—	—	—	—	1/1	—	1/1	50 mm in length.
Gobius giuris	—	—	—	—	—	—	—	—	—	—	1/1	1/1	70 mm in length.
Puntius sp.	1/1	1/1	—	—	—	—	—	—	—	—	1/1	—	145 to 161 mm in length.
Class AMPHIBIA													
Family Bufonidae													
Bufo melanostictus	—	—	—	—	—	—	—	—	—	—	6/1	—	Tadpoles.
Family Ranidae													
Rana tigerina	1/1	—	—	1/1	—	—	1/1	—	—	2/1	—	—	
Rana limnocharis	—	1/1	—	—	—	—	—	—	—	1/1	2/1	—	

TABLE 1 (Continued)

Classified food items	Months: Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Remarks
Class REPTILIA													
Family Scincidae													
Mabuya carinata	—	1/1	—	—	—	—	—	—	—	—	—	—	
Order OPHIDIA													
Family Colubridae													
Xenochrophis piscator	1/1	—	—	—	—	—	—	—	—	—	1/1	—	Non-poisonous.
Amphiesma stolata	—	—	—	—	—	—	—	2/2	—	—	—	—	Half digested (non-poisonous).
Lycodon aulicus	—	—	—	—	—	1/1	—	—	—	—	—	—	A part only.
Class MAMMALIA													
Rattus rattus	1/1	1/1	—	—	—	—	—	1/1	1/1	1/1	—	1/1	Pest of crops.
Suncus murinus	1/1	—	—	—	1/1	—	—	1/1	—	—	1/1	—	
Vegetable matter	ve/4	ve/8	—	—	ve/2	—	—	ve/3	—	—	ve/4	—	ve = Vegetable.
Gravel	gr/10	gr/5	gr/15	gr/12	gr/9	gr/20	gr/12	gr/14	gr/10	gr/14	gr/11	gr/8	gr = Gravel.

TABLE 2

INSECTS CONSUMED BY *R. tigerina* (DAUD.) GROUPED ACCORDING TO THEIR ECONOMIC IMPORTANCE

	Species	Number of insects	Number of Frogs examined
	Insect pests of crops		
1.	*Gryllotalpa africana*	9	6
2.	*Gryllotalpa* sp.	63	23
3.	*Brachytrypes* sp.	19	10
4.	*Hieroglyphus banian*	29	13
5.	*Parella* sp.	21	13
6.	*Scelimena* sp.	33	18
7.	*Corixa* sp.	22	6
8.	*Eristalis* sp.	50	26
9.	*Ophanus indicus*	10	7
10.	*Anomala elata*	62	30
11.	*Anomala bengalensis*	24	19
12.	*Batocera* sp.	38	17
13.	Chrysomelid	66	17
	Total	446	205
	Insects injurious to trees		
1.	*Mecopoda elongata*	11	8
2.	*Solenopsis geminata*	39	9
3.	*Oecophylla smaragdina*	21	4
4.	*Onitis* sp.	5	4
	Total	76	25
	Household pests		
1.	Cockroach	11	6
2.	Termites	37	12
3.	*Musca* sp.	18	3
4.	*Priotyrannus mordax*	17	9
	Total	83	30

TABLE 2 (continued)

Species	Number of specimens	Number of Frogs examined
Carnivorous		
1. *Holochlora albida*	15	13
2. *Callimenelus opacus*	6	4
3. *Labidura riparia*	26	23
4. *Belostoma indica*	13	12
5. *Sphaerodema* sp.	12	9
6. *Laccotrephes ruber*	18	12
7. *Rhynchium* sp.	6	5
8. *Pherosophus* sp.	9	8
9. *Cybister* sp.	12	9
10. *Stethoxus* sp.	18	13
11. *Catharsius molossus*	10	6
12. Elaterid	22	10
Total	167	124
Indeterminate		
1. *Camponotus compressus*	28	20
2. Odonata	8	4
3. *Pseudoblaps* sp.	13	9
Total	49	33
1. *Harpalus* sp.	29	8
2. *Schizodactylus monstruosus*	6	5
3. Heterocera	45	7
4. *Aphaenogaster beccarii*	45	7
Total	125	27
Useful insect		
1. *Apis dorsata*	3	3

TABLE 3

FOOD ITEMS BY THEIR NUMBER AND WEIGHT AS CONSUMED BY DIFFERENT 20 MM SIZE GROUPS OF *Rana tigrina* (DAUD.)

Size	Annelida No./wt. gm.	Molluscs No./wt. gm.	Insects No./wt. gm.	Crabs No./wt. gm.	Arachnids No./wt. gm.	Pisces No./wt. gm.	Amphibians No./wt. gm.	Reptiles No./wt. gm.	Birds No./wt. gm.	Mammals No./wt. gm.
50-69	3/0.7	4/1.5	97/13.5	4/14.5	*66/3.5	—	—	—	—	—
70-89	2/0.5	2/0.7	103/12.2	7/25.0	1/5.2	—	**6/2.2	—	—	—
90-109	2/0.5	3/0.4	109/16.9	9/31.2	2/4.5	1/7.5	1/45.5	1/13.5	—	1/11.5
110-129	—	2/0.7	146/18.2	12/43.4	2/6.4	2/16.2	3/35.3	1/43.8	—	2/26.4
130-149	—	—	177/26.8	15/51.7	3/5.3	2/12.5	3/32.4	1/53.9	—	2/42.8
150-169	—	—	147/16.4	20/69.2	4/3.2	3/16.5	2/27.2	1/51.2	1/13.5	2/31.2
170-	—	—	143/15.3	37/127.5	3/6.5	3/14.2	2/64.3	2/69.3	—	3/57.5

* Small spiders ** Tadpoles

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The exotic Flora of Ranchi[1]

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(*With a map*)

Ranchi, the summer capital of Bihar, has a rich exotic flora which forms a dominant part of the landscape. The study covers 209 exotic species and varieties of gymnosperms and angiosperms that are cultivated or naturalized in the district. An attempt has been made to determine the country of origin of the exotics, aliens and neophytes of Ranchi which were studied both in the field and in the laboratory during the years 1957-1959, 1964-1967 and 1970. The study reveals that exotic plants were introduced in this region both adventitiously and intentionally for purposes of food and fodder, forage, medicine, ornament, afforestation, green manuring and soil conservation. In addition, a large number of exotic weeds have also been introduced in the district, either intentionally as ornamental plants or accidentally with food grains, ballast, packing materials and seeds of economic plants.

INTRODUCTION

Ranchi (23°22′ N, 85°22′ E), the summer capital of Bihar, is situated on a picturesque undulating plateau at an altitude of 655 m above sea level. It forms a distinct physical unit of Bihar (*see* also map). The Damodar river forms the northern boundary of the district. The Subarnarekha river originates near Piska and passes through Ranchi city. The Koel, Sankh, Kanchi and Kharkai are other important rivers which flow through the district. The Subarnarekha river forms the most attractive waterfall in Bihar at Hundru, situated at a distance of 35 km east of Ranchi with a drop of over 80 m. There are also noteworthy waterfalls like Dassam, Sadni, Johna and Sita. The climate is of the tropical monsoon type with an annual average rainfall of 1476 mm. The maximum temperature reaching to 40°C has been recorded in the month of May. The minimum temperature of 7°C has been recorded in the month of December. The relative humidity is higher during the months from June to August, being maximum in the months

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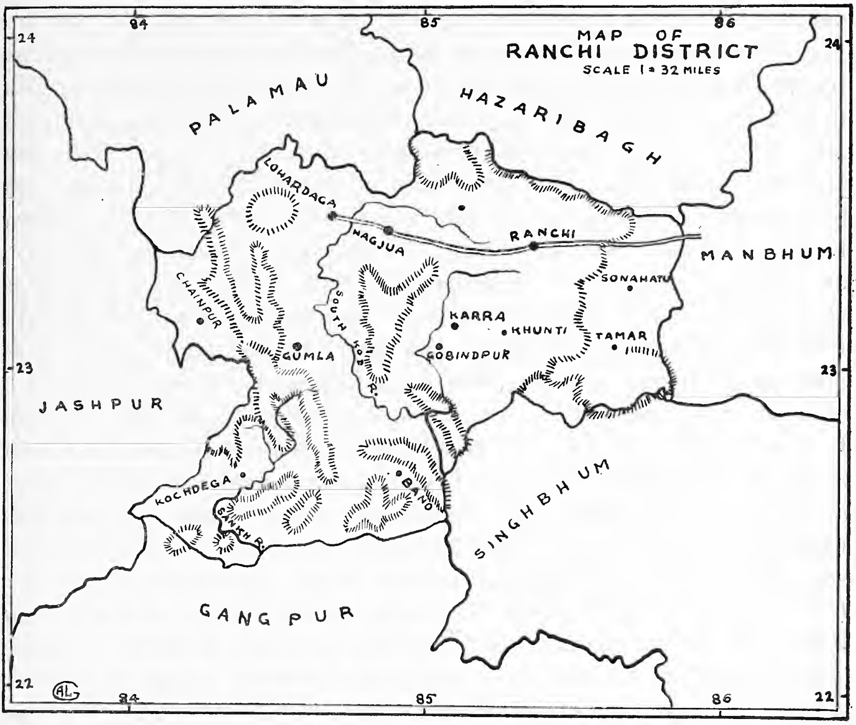
of July and August (88%) and minimum in the month of April (39%). The soils are of various types, i.e. sandy-loam, gravel, red-ferruginous, alluvial and even black sticky clay.



Map showing geographic location of the study area of Ranchi District, Bihar.

Ranchi is a famous hill station of the region. In the later part of the 19th century, it became the summer headquarters of the British. During this period, a number of exotic plants were introduced for beautifying the landscape. We made a systematic study of the exotics, aliens and neophytes of Ranchi during the years 1957-1959, 1964-1967 and 1970. The exotic flora of Ranchi forms today a dominant part of its gardens, parks and landscape. However, the existing floras are inadequate for the identification of exotic plants. The present study, therefore, covers 209 exotic species and varieties of gymnosperms and angiosperms that are cultivated or naturalized in the district. The data on the country of origin and probable time of their introduction into India are determined. It may be mentioned that the time of introduction of species is in many cases difficult to determine, as exact records of their introduction are lacking. Much of the information on the early history of plant introduction is scattered in the old travel records of several visitors and dignitaries to India and in the classical works of

Moghul emperors, Missionary botanists and the European officials and explorers, especially the Portuguese, Dutch, Spaniards, French and the British.

The earliest collection of plants in this area was made by Clarke, Gamble, Wood, Ball and Rev. Cardon. In his discussion of the immigration of plants into Bengal and Bihar, Bruhl (1908) mentioned some plants from Ranchi. The introduction of exotic plants in this region took place both adventitiously and intentionally for purposes of food and fodder, forage, medicine, ornament, afforestation, green manuring and soil conservation. The exotic flora of Ranchi includes useful crops like cereals (*Zea mays* L.), pasture and fodder grasses (*Chloris gayana* Kunth, *Panicum maximum* Jacq., *Pennisetum clandestinum* Hochst. ex Chiov., *P. purpureum* Schumach.), green manure or cover crops (*Calopogonium mucunoides* Desv., *Centrosema pubescens* Benth., *Pueraria phaseoloides* Benth., *Trifolium alexandrinum* L.), fruits (*Manilkara achras* Fosberg, *Annona squamosa* L., *Carica papaya* L., *Anacardium occidentale* L., *Averrhoa carambola* L., *Psidium guajava* L.), vegetables and tuber crops (*Manihot esculenta* Crantz, *Ipomoea batatas* L., *Solanum tuberosum* L.), drugs and medicinal plants (*Erythroxylum coca* Lamk.), and ornamental trees, shrubs and climbers (*Schizolobium excelsum* Vog., *Samanea saman* Merr., *Bougainvillea spectabilis* Willd., *Callistemon citrinus* Stapf, *Quisqualis indica* L., *Hibiscus schizopetalus* Hook. f., *Cassia siamea* Lamk., *Delonix regia* Rafin., *Allamanda cathartica* L., *Thevetia peruviana* K. Schum., *Jacaranda mimosifolia* D. Don, etc.), and garden annuals, foliage or bulbous plants (*Araucaria columnaris* Hook., *Cupressus sempervirens* L., *Thuja orientalis* L., *Portulaca grandiflora* Hook., *Dahlia pinnata* Cav., *Antirrhinum majus* L., *Amaryllis belladonna* L., *Haemanthus coccineus* L., *Gladiolus gandavensis* Van Houtte). A large number of exotic weeds have also been introduced in the district, either intentionally as ornamental plants or accidentally with food grains, ballast, packing materials and seeds of economic plants. These include noxious weeds and pests like *Argemone mexicana* L., *A. ochroleuca* Sweet, *Gomphrena celosioides* Mart., *Opuntia dillenii* Haw., *Croton bonplandianum* Baill., *Acanthospermum hispidum* DC., *Eichhornia crassipes* Solms, *Ipomoea fistulosa* Mart. ex Choisy, *Convolvulus arvensis* L., *Martynia annua* L., and *Hyptis suaveolens* Poit.

Enumeration of Species

1. Cycadaceae

1. **Cycas revoluta** Thunb. Sago Cycas

Native of China and Japan (MacMillan 1952). Introduced in Indian

Botanic Garden, Sibpur near Calcutta in 1794 (Voigt 1845). Frequently grown in private and public gardens for its ornamental foliage.

2. Araucariaceae

2. **Araucaria columnaris** Hook.
Syn. *A. cookii* R. Br. Columnar Araucaria.
Native of New Caledonia (Bailey 1949). Planted in gardens for its ornamental foliage.

3. Pinaceae

3. **Pinus roxburghii** Sarg.
Syn. *P. longifolia* Roxb. Chirpine
Native in the Outer Himalayas and extends from Bhutan to Afghanistan. Commonly cultivated in public and private gardens.

4. Cupressaceae

4. **Cupressus sempervirens** L. Mediterranean Cypress; Italian Cypress
Native of S. Europe and W. Asia. It is the ancient classical Cypress of Greeks and Romans; introduced into India at an early time. Occasionally grown in gardens for its ornamental foliage.

5. **Thuja orientalis** L. Oriental Arbor-vitae.
Syn. *Biota orientalis* (L.) Endl. *Platycladus orientalis* Franco.
Indigenous to China and Japan (MacMillan 1952). Introduced into India during the last quarter of the 17th century. Frequently planted for its ornamental foliage. Local name: *Morpankhi*.

5. Magnoliaceae

6. **Magnolia grandiflora** L. Bull Bay; Southern Magnolia; Tree Lotus
A tropical American species; introduced into India probably during the year 1840. Occasionally planted in gardens.

6. Annonaceae

7. **Annona reticulata** L. Bullock's Heart; Ramphal
Native of tropical America. Introduced into India during the last quarter of the 17th century; now completely naturalized (Voigt 1845). Cultivated for its fruits.

8. **A. squamosa** L. Sugar Apple; Sweetsop; Sitaphal
Native of tropical America. It was one of the first American plants introduced probably by the Portuguese into India during the 16th

century (Merrill 1954); frequently cultivated and widely naturalized in India.

7. Papaveraceae

9. **Argemone mexicana** L. Mexican Poppy

Native of Mexico and other parts of Central America. Introduced into India at an early time. Common in waste lands, roadsides, recently disturbed soils, etc.

10. **A. ochroleuca** Sweet. Prickly Poppy

An introduced Mexican weed in India; often found mixed with *A. mexicana* Linn. in waste lands and recently disturbed soils near Hathikhana, Ranchi.

11. **Eschscholzia californica** Schau. Californian Poppy

Native of America (Bailey 1949). Flowers remain open during the day, pale-yellow to orange. Cultivated in gardens as an annual.

8. Brassicaceae

12. **Eruca sativa** Mill. Garden Rocket

Native of Eurasia (Robbins 1940). Frequently cultivated as a winter-season crop.

9. Caryophyllaceae

13. **Dianthus caryophyllus** L. Carnation

Native of Europe and North Africa (Backer & Brink 1963). Commonly cultivated in gardens as an ornamental annual.

14. **Silene conoidea** L.

Native of temperate Asia and Europe. A few plants were located in vegetable plots and wheat fields of the district.

15. **Spergula arvensis** L. Corn Spurry

An introduced European weed (Ridley 1930; Backer & Brink 1963); probably introduced as an impurity in vegetable seeds. Frequently found as a winter-season weed in cultivated fields and fallow land.

10. Portulacaceae

16. **Portulaca grandiflora** Hook. Rose-Moss

Native of South America (Walters 1964). Cultivated in gardens and hanging baskets; introduced into India by the Portuguese during the last part of the 16th century.

17. **P. oleracea** L. Purslane

A well-known weed in Europe. Frequently found as a weed in gardens and cultivated grounds.

11. Theaceae

18. **Camellia japonica** L. Garden Camellia; Japanese Rose

Syn. *Thea japonica* (L.) Nois.

Native of Japan (Backer & Brink 1963). Introduced into India about 1795. Not common; often planted in private and public gardens.

12. Malvaceae

19. **Althaea rosea** (L.) Cav. Hollyhock

Native of China or Asia Minor (Backer & Brink 1963). A tall herb with hairy stems. Introduced into India about 1835. Common in gardens. Local name: *Gul-Khera.*

20. **Hibiscus mutabilis** L. Cotton-Rose

Native of China. Commonly cultivated in gardens.

21. **H. rosa-sinensis** L. Rose of China; Chinese Hibiscus; Shoe Flower

Native of China (Li 1959; Pal & Krishnamurthi 1967). According to Robyns (1966), it is presumably indigenous to eastern Asia; now common in all warm countries. Extensively planted as an ornamental hedge plant.

22. **H. schizopetalus** (Mast.) Hook. f. Fringed Hibiscus

Native of tropical East Africa (Robyns 1966); introduced into India (Pondicherry) in October 1886 (Gupta & Marlange 1961). Common in private and public gardens.

23. **Malachra capitata** L.

Native of tropical America (Backer & Brink 1963). Introduced into India in the middle of the 19th century as a fibre plant. Occurs commonly in the area.

24. **Malvastrum coromandelianum** (L.) Garcke

A widely distributed weed of American origin; first described from the material collected in the Old World (Merrill 1945). Common in fields and waste lands.

13. Bombacaceae

25. **Adansonia digitata** L. Baobab; Monkey-Bread Tree

Native of tropical Africa. It is considered to be one of the longest lived trees in the world. It was introduced by Arab traders and by African negroes employed in the Moghul army. Some trees are planted near Dorunda Bridge, Ranchi.

14. Sterculiaceae

26. **Dombeya mastersii** Hook. f. Masters Dombeya
Native of tropical Africa (MacMillan 1952). Occasionally cultivated in gardens as an ornamental shrub.

27. **Kleinhovia hospita** L. Tanag
Native of Malaysia. Cultivated in gardens.

15. Erythroxylaceae

28. **Erythroxylum coca** Lamk. Cocaine Plant
Indigenous to Peru and Bolivia. It was introduced into Ceylon in 1870 and its cultivation was prohibited in British colonies in 1914 (MacMillan 1952). Cultivated for the drug cocaine which is derived from its leaves.

16. Geraniaceae

29. **Achimenes grandiflora** DC. Bigpurple Achimenes
Native of tropical America. Introduced into Calcutta Botanic Garden in 1838. Commonly cultivated in gardens.

17. Oxalidaceae

30. **Averrhoa carambola** L. Carambola; Komarac
A tropical species; now widely spread in the hotter regions. Duthie (1903) suggested that the species was introduced into India from America by the Portuguese in the 16th century. Hill (1952) considered it to be a native of South-eastern Asia. Hayes (1957) believed it to be a native of Moluccas or of Malayan region. Cultivated in gardens for its fruits.

31. **Oxalis corniculata** L. Yellow Oxalis; Yellow Wood Sorrell
A native of Europe (Robbins 1940). Common in lawns, green houses and gardens. Local name: *Pusi-ganju.*

18. Tropaeolaceae

32. **Tropaeolum majus** L. Garden Nasturtium
Native from Peru to Columbia (Backer & Brink 1963). Flowers yellow, red or scarlet. Cultivated as a garden annual in beds and borders.

19. Rutaceae

33. **Citrus maxima** Merr. Pummelo or Shaddock
Native of Malaysia and Polynesia (Maheshwari 1961). Introduced

into India from Java and into West Indies by Captain Shaddock (Bruhl 1908). Cultivated for its fruit.

20. Meliaceae

34. **Melia azedarach** L. Persian Lilac

Native of Persia, Asia Minor, etc. Commonly cultivated as an ornamental tree.

35. **Swietenia mahagoni** Jacq. Mahogany

Native of tropical America (Backer & Brink 1965). It was introduced into Indian Botanic Garden, Calcutta in 1795 from the West Indies (Roxburgh 1824). Commonly planted in gardens.

21. Sapindaceae

36. **Litchi chinensis** Sonner. Lychee

A Chinese species; reported to have been introduced into India towards end of the 18th century. Commonly cultivated for its fruit.

22. Anacardiaceae

37. **Anacardium occidentale** L. Cashew; Kaju

Native of Brazil and appears to have been under cultivation throughout tropical America before the voyage of Columbus to the New World. It seems to have been introduced into India from Brazil by the Portuguese in the 16th century and is now naturalized in the forests of Chittagong and all over the coastal regions of India (Mehra 1966).

Acosta (1578) mentioned: "This tree gives a fruit called *caju*, which being a good stomachic, and of good flavour, is much esteemed by all who know it. This fruit does not grow everywhere, but is found in gardens at the city of Santa Cruz in Cochin". Frequently cultivated in private gardens.

23. Papilionaceae

38. **Aeschynomene americana** L. American Sensitive Plant; American Jointvetch

Native of tropical America; introduced into India in recent years. It was reported for the first time from Hazaribagh (Chatterjee 1960), and found lately in the vicinity of Kanke, near Ranchi.

39. **Arachis hypogea** L. Peanut; Groundnut

Native of Brazil; probably introduced into India in the 16th century. Commonly cultivated for its pods.

40. **Calopogonium mucunoides** Desv.

Native of America (Backer & Brink 1963). It was introduced into Burma in 1920. Cultivated as a green manure.

41. **Centrosema pubescens** Benth. Centro

Native of tropical America. Introduced into India during the early part of 19th century. It has been cultivated in Malaya since 1921 in rubber, oil-palm and coconut plantations. Cultivated at Kanke as a cover crop.

42. **Crotalaria incana** L. Woolly Rattle Pod

Native of America (Backer & Brink 1963). Bressers (1951) reported it from Khunti (Ranchi) where it is now naturalized. Not common.

43. **Gliricidia sepium** (Jacq.) Kunth ex Walp. Madre

Native of eastern region of Central and South America (Backer & Brink 1963). It was introduced into Bombay from Ceylon in 1916 and plants were raised from the seeds. Cultivated as an ornamental tree.

44. **Lathyrus aphaca** L.

An Eurasian species; found as a weed in cultivated fields and used as fodder.

45. **Lens culinaris** Medik. Lentil

Syn. *L. esculenta* Moench.

Indigenous to Central Europe, Mediterranean region and Western Asia including Afghanistan. Introduced into India by the early Aryan settlers (Bruhl 1908). Cultivated for the seeds.

46. **Medicago lupulina** L. Black Medic

Native of Europe; introduced into India during the 15th or 16th century by European settlers. Common as a winter-season weed in waste grounds and cultivated fields.

47. **M. polymorpha** L. Bur Clover; Burr Medic

Syn. *M. denticulata* Willd.

Native of Europe; probably introduced into India during the 15th or 16th century along with wool to which its fruits adhere by their curved spines. A common weed in cultivated fields.

48. **Melilotus alba** Desr. White Sweet Clover; Bokhara Clover

Indigenous to Europe and western temperate Asia. Naturalized as a winter season weed in moist situations and cultivated fields.

49. **M. indicus** (L.) All. Yellow Sweet Clover; Hexham Scent

Native of South Europe and South-Western Asia (Backer & Brink 1963); introduced into India at an early time. Common in waste lands and grassy areas.

50. **Pueraria phaseoloides** (Roxb.) Benth. Kudzu
Syn. *P. javanica* Benth.
A native of tropical Asia; first introduced into the Tenasserim Circle, Burma in 1929 from Java (Anon. 1936). Cultivated at Kanke, near Ranchi as a green manure.

51. **Trifolium alexandrinum** L. Berseem; Egyptian Clover
Native of Egypt and Syria (Maheshwari 1963). According to a report by the Agricultural Research Institute, Pusa, berseem was introduced into India in 1917 from Egypt. Cultivated at Kanke and other agricultural farms as a green manure.

52. **Vicia hirsuta** (L.) Gray. Tiny Vetch
Native of Europe, West Africa and Continental Asia (Backer & Brink 1963). According to Duthie (1903), it was introduced into India from Europe, where the plant is common. Common in cultivated fields and waste lands.

53. **V. sativa** L. Common Vetch
Native of Europe, North Africa and West Asia (Backer & Brink 1963). Introduced as a forage and cover crop in many parts of the world. Common in cultivated fields and moist, waste grounds.

24. Caesalpiniaceae

54. **Bauhinia tomentosa** L. St. Thomas-Tree
Native of tropical Asia and Africa. According to J. D. Hooker, it was introduced at Kew in 1860, and probably came to India about 1872 (Bor & Raizada 1954). Cultivated in private and public gardens.

55. **Poinciana pulcherrima** L. Flowerfence Poinciana
Probably native of South America. According to Van Rheede (1686), it was cultivated in Indian gardens as early as 1680. Commonly cultivated as an ornamental in hedges and garden shrubberies.

56. **Cassia javanica** L. White and Pink Shower
Native of Sumatra and Java. Introduced into India in the late 17th century. Planted in gardens, parks and roadsides.

57. **C. occidentalis** L. Coffee Senna
A circumtropical weed, possibly of S. American origin. Introduced long before the publication of Roxburgh's *Flora Indica* (1824). Common along roadsides and in waste lands. Local name: *Chakundar.*

58. **C. renigera** Wall. ex Benth.
Native of dry zone of Upper Burma; introduced into India in the late 17th century (Troup 1921). Cultivated in gardens and roadsides.

59. **C. siamea** Lamk. Yellow Shower; Siam Cassia

Native of South-east tropical Asia (Backer & Brink 1963). It was planted in Namkum (Ranchi) in the middle of the 18th century for lac culture. Planted in gardens.

60. **C. sophera** L.

Introduced from tropical America. Naturalized in waste lands.

61. **C. tora** L. Sickle-Pod

Native of America (Backer & Brink 1963). Introduced in the early 17th century and became widespread in India by 1824 (Srivastava 1964). A common weed along roadsides, in waste grounds, etc. Local name: *Chakundar*.

62. **Colvillea racemosa** Boj. Colville's Glory

Native of Mauritius and Madagascar. Introduced in the Indian Botanic Garden, Calcutta in 1840 (Voigt 1845). Cultivated as an ornamental tree.

63. **Delonix regia** (Boj. ex Hook.) Rafin. Peacock-Flower; Flame Tree; Gulmohr

Syn. *Poinciana regia* Boj. ex Hook.

Native of Madagascar. Some plants were taken to Mauritius about 1824 and their seeds were brought to England. It was then introduced into tropical countries (Cowen 1950). Bruhl (1908) mentioned that it was introduced into India from Mauritius about the year 1840. Commonly cultivated as an ornamental tree.

64. **Schizolobium excelsum** Vog. Brazilian Fire Tree

Native of S. America (Backer & Brink 1963). Introduced into India in the middle of the 18th century. Planted in avenues and gardens.

65. **Tamarindus indica** L. Tamarind

Probably a native of tropical Africa. It is said to be Sudanic in origin (Murdock 1959). In India, it was introduced at an early time. Commonly planted along roadsides, in gardens, etc. Local name: *Jojo*.

25. Mimosaceae

66. **Acacia decurrens** Willd. Green Wattle

Native of Australia (Backer & Brink 1963). According to Matthew (1969), Wattle was introduced in Kodaikanal by Sir Vere Levinge in 1867, but large scale introduction began only in 1883. It was also introduced in the Nilgiris in 1832 by Capt. Dunn. Planted in the area.

67. **A. farnesiana** Willd. Cassie; Sweet Acacia; Aroma

Native of tropical America; introduced during the 18th century. Occasionally cultivated in hedges and fields.

68. **Leucaena leucocephala** (Lamk.) Wit.
Syn. *L. glauca* Benth.
Native of the warmer parts of the New World; now cultivated and naturalized in tropical countries.

69. **Mimosa pudica** L. Sensitive Plant
Native of Brazil and was introduced into India at a very early time. Occurs in waste lands, roadsides, etc.

70. **Pithecellobium dulce** (Roxb.) Benth. Manila Tamarind
Indigenous to Mexico. It is an early introduction by the Spaniards into the Philippine Islands and then into India. It is said to be sensitive to frost and does not succeed on the Ranchi plateau (Haines 1922).

71. **Samanea saman** (Jacq.) Merr. Rain-Tree
Native of tropical America. Introduced in the vicinity of Calcutta and the plantations of Kadapah and Kadur, etc. as an ornamental tree of rapid growth during the first half of the 18th century (Bruhl 1908). Cultivated as an ornamental or avenue tree.

72. **Prosopis juliflora** DC. Mesquite
Native of the arid regions of Mexico and Central America; introduced into India from Kew, England in 1877 for afforestation purposes. Cultivated in hedges.

26. Rosaceae

73. **Eriobotrya japonica** (Thunb.) Lindl. Loquat; Japanese Medlar
Native of Japan (Backer & Brink 1963). Cultivated for its fruits which are sold in the market.

74. **Prunus persica** (L.) Batsch. Peach
Native of China (Backer & Brink 1963). It was recorded from Palnis, S. India in 1858 by Beddome. Planted in gardens.

75. **Rosa banksiae** Ait. f. Banksia Rose
Native of China. Commonly planted in gardens.

76. **R. damascena** Mill. Damask Rose
Origin unknown; probably a cultigen. It is not till the close of the 13th century that we find any reference of rose-water. In India, attar of roses is said to have been first discovered by Begum Nur-i-Jehan in 1612 A.D. (Bruhl 1908). Commonly cultivated.

77. **R. centifolia** L. Cabbage Rose
Native of Caucasus. It is one of the most ancient of cultivated roses. Introduced into Calcutta Botanic Garden in 1841 (Voigt 1845).

27. Crassulaceae

78. **Kalanchoe pinnata** Pers. Lefe-Plant.

Syn. *Bryophyllum pinnatum* Oken; *B. calycinum* Salisb.

Native of Africa (Backer & Brink 1963). Introduced into Calcutta Botanic Garden by Lady Clive in 1799 and thence spread all over Bengal (Voigt 1845). Frequently found in private gardens.

28. Combretaceae

79. **Quisqualis indica** L. Rangoon-Creeper

Native of Burma, Malaya, New Guinea and Philippines (Bailey 1949). Commonly cultivated in gardens for ornamental purposes.

29. Myrtaceae

80. **Callistemon citrinus** (Curt.) Skeels. Lemon Bottle-Brush

Syn. *C. lanceolatus* Sweet.

Native of Australia (Backer & Brink 1963). Introduced into India about the year 1804. Cultivated in gardens.

81. **Eucalyptus citriodora** Hook. Lemon-Scented Gum

Native of Australia. An early introduction into India; first introduced at Nandi Hills by Tipoo Sultan. Frequently planted.

82. **E. camaldulensis** Dehnh. Red Gum

Syn. *E. rostrata* Schlecht.

Native of Australia; introduced in Punjab, Uttar Pradesh and Rajasthan. It grows well in some plantations in the district.

83. **Melaleuca leucadendra** (L.) L. Cajeput Tree; Punk Tree

Syn. *M. leucadendron* L.f.

Introduced into Calcutta Botanic Garden in 1811 (Bruhl 1908). Cultivated in gardens as an ornamental tree.

84. **Psidium guajava L.** Guava

Native of tropical America. It is a typical Mexican introduction via the Acapuloc-Manila Galleon route, after 1565 into the Old World Tropics (Merrill 1954). Introduced into India by the Portuguese (Watt 1892). Commonly cultivated for its fruit. Local name: *Tambarsa.*

30. Punicaceae

85. **Punica granatum** L. Pomegranate

Native of Iran and now naturalized in the Mediterranean area and southern Asia. Cultivated for its fruits.

31. Caricaceae

86. **Carica papaya** L. Papaya

Native of tropical America. It was not known in India before the

arrival of the Portuguese, who introduced it in the 16th century (Mehra 1965). Commonly cultivated for its fruit.

32. Passifloraceae

87. **Passiflora edulis** Sims. Purple Granadilla; Edible Passion-Flower
Native of Brazil (Bor & Raizada 1954). Introduced into India about 1826. Rather uncommon in the area.

88. **P. foetida** L. Stinking Passion-Flower
An American species; introduced into India during the 19th century (Srivastava 1964).

33. Cactaceae

89. **Opuntia dillenii** Haw. Prickly Pear
Native of Mexico; now naturalized all over India. It was introduced in Europe as early as at the end of the 15th century (Bally 1969). It was brought in India well before 1800 A.D. from Europe with the object of establishing the cochineal industry. Frequently found in waste lands and fences. Local name: *Nagphani.*

34. Araliaceae

90. **Polyscias fruticosa** (L.) Harms.
Syn. *Panax fruticosa* Hort.
Native of tropical Asia. This shrub was introduced into Indian Botanic Garden, near Calcutta from Moluccas in 1798 (Bruhl 1908). Cultivated in hedges.

35. Rubiaceae

91. **Coffea arabica** L. Arabian Coffee
Native of Abyssinia (Backer & Brink 1965). Voigt (1845) writes: "From Arabia and Ethiopia, it has been carried to nearly all parts of the world within the tropics". It might have been cultivated in India from the 18th century. Cultivated in the area.

92. **Gardenia jasminoides** Ellis.
Syn. *G. florida* L. Rosal
Native of China and Japan (Backer & Brink 1965). Introduced into India in the 17th century. Cultivated in gardens and hedges.

93. **Hamelia patens** Jacq. Scarlet Hamelia
Syn. *H. erecta* Jacq.
Native of S. America and southern parts of N. America (Backer & Brink 1965); introduced into India in the early 18th century. Accord-

ing to Bruhl (1908), the species flowered in Indian Botanic Garden in 1840. Cultivated in gardens and hedges.

94. **Mussaenda flava** (Verdcourt Bakh. f.

Syn. *M. luteola* Delile *nom. illeg.*

Native of Africa (Haines 1922). It was first introduced into Europe about 1860 (Bor & Raizada 1954), and came to India in the later part of the 18th century. Cultivated as an ornamental shrub in gardens and parks.

95. **Richardia brasiliensis** Gomez.

Syn. *Richardsonia pilosa* H. B. & K. Mexican Clover

Native of S. America (Backer & Brink 1965). Introduced into India in the early 19th century. It was first reported from Shillong by Kanjilal *et al.* (1939). Very common in Kanke and Boria along roadsides, in waste lands and cultivated fields. Local name: *Hadapoda.*

36. Asteraceae (nom. alt.: Compositae)

96. **Acanthospermum hispidum** DC. Star Burr

Native of tropical America. It was introduced into South India along with ballast and packing material of some imported goods. Gamble (1921) first reported it from South Kanara and Salem districts. Later, Srivastava (1964) reported it from Ranchi. Occurs as a weed along roads, railways and in forest clearings.

97. **Adenostemma lavenia** (L.) Ktze.

Syn. *A. viscosum* Forst.

Native of South America, and was widespread throughout India in the 19th century. Not common; found in grassy areas in valleys.

98. **Ageratum conyzoides** L. Tropic Ageratum

A South American species now well naturalized throughout India. Ridley (1930) mentioned that it travels by adhesion to cloth or to hair of animals. Very common in waste lands, roadsides and cultivated fields. Local name: *Pooru.*

99. **Blainvillea acmella** (L.) Philipson.

Syn. *B. rhomboidea* Cass.; *B. latifolia* DC.

Native of South America (Ridley 1930); introduced into India during the 18th century. Frequently found in moist, waste lands.

100. **Brachycome iberidifolia** Benth. Swan River Daisy

Native of Australia (Bailey 1949). Cultivated as a garden annual.

101. **Calendula officinalis** L. Marigold

Native of S. Europe. (name, *Calendula* means 'of the Kalends' i.e. the first of every month—because Marigold can be found in bloom in almost every month of the year). Coats (1956) mentioned: "Some

authorities give 1753 as the date of introduction of the marigold into England from Europe, but there are numerous references to it in the 13th or 14th centuries and it seems to have been widespread and familiar even then". It is said that the pain of a wasp or bee sting can be alleviated by rubbing with the flower. Extensively cultivated in gardens, parks, etc.

102. **Chrysanthemum cinerariaefolium** (Trev.) Vis. Dalmatian Pyrethrum

Syn. *Pyrethrum cinerariaefolium* Trev.

Native of Dalmatia (Bailey 1949). Introduced into Pondicherry, India in 1886 (Gupta & Marlange 1961). Matthew (1962) mentions: "The flowers of the Pyrethrum were in great demand during World War II, when its value as an insecticide was realized........ The Government of India urged the Madras State Government,........ to undertake large scale planting...... The scheme was already started in the Nilgiris in 1942 with seeds brought from Kenya". Cultivated in gardens and sometimes found as an escape.

103. **Coreopsis tinctoria** Nutt. Golden Coreopsis

A native of N. America (Coats 1956). Several varieties were introduced in many gardens near London by 1725. This species probably came to India about 1740. Extensively cultivated in gardens.

104. **Cosmos bipinnatus** Cav. Common Cosmos

Native of Mexico. Common in gardens as a border annual; used for table decoration.

105. **Dahlia pinnata** Cav. Aztec Dahlia

Syn. *D. hortensis* Guill.

Native of Mexico. It was discovered by Von Humboldt in 1789, when the seeds were sent to the Royal Garden, Madrid. From there, it was imported into England in 1804 by the Marchioness of Bute. In India, it was probably introduced in 1865 (Maheshwari 1955). It is a favourite garden plant in the area.

106. **Elephantopus scaber** L.

An American weed; introduced in to the Old World during post-Columbian time and is now widespread throughout the region. Common in waste lands, forest undergrowth, etc. Local name: *Tape-Singh.*

107. **Erigeron bonariensis** L. Fleabane

Syn. *E. linifolius* Willd.

Native of the American tropics and now pantropical in distribution. It was introduced into the Old World in the 16th century. Common in gardens, lawns, etc.

108. **Gaillardia picta** Sweet. Painted Gaillardia

Native of North America. It is a popular annual in garden beds and is extensively used for the decoration of bowls and vases.

109. **Galinsoga parviflora** Cav. Kew Weed; Yellow Weed

Native of tropical America; now well naturalized in the country and grows abundantly in cultivated plots near Ranchi. Local name: *Pardhia.*

110. **Lagascea mollis** Cav.

An introduced Mexican weed in India; now well naturalized all over the hilly region.

111. **Sclerocarpus africanus** Jacq.

Native of South America. Introduced into India about 1872 and became common throughout the region (Srivastava 1964). Bressers (1951) first reported it from Ranchi. Common amongst grass.

112. **Tagetes erecta** L. Aztec or African Marigold

Native of Mexico; once supposed to be a native of Africa (Bailey 1949). Flowers yellow to orange. Cultivated as a garden annual.

113. **Tithonia diversifolia** A. Gray. Wild Sun Flower

Native of Central America (Bailey 1949). It was introduced in Ceylon in 1851. Flower heads yellow, like sunflower. Cultivated in gardens as an annual.

114. **Tridax procumbens** L.

Native of the New World; introduced into India about the year 1830 as an ornamental plant (Ridley 1930). It is now widespread over tropical India. Very common on old walls, in grasslands, roadsides, waste lands, etc. Local name: *Manduli-ba.*

115. **Zinnia elegans** Jacq. Common Zinnia

Native of Mexico (Bailey 1949). Extensively cultivated as a rainy and summer-season garden annual.

37. LOBELIACEAE

116. **Lobelia radicans** Thunb.

It was accidentally introduced from China into the Indian Botanic Garden, Sibpur, near Calcutta. Naturalized in the vicinity of Ranchi (Bruhl 1908).

38. PRIMULACEAE

117. **Anagallis arvensis** L. Scarlet Pimpernel

Indigenous to Europe and Mediterranean region (Taylor 1955). It was introduced into India about 1500-1665 by the early Dutch settlers

from the East Indies or by the Spaniards into the Philippines. It is probable that it was introduced into E. Bengal, Assam, etc. as an impurity, at some time with the vegetable seeds or seeds of garden plants. Common in garden beds and in moist situations.

39. Sapotaceae

118. **Manilkara achras** (Mill.) Fosberg. Sapodilla; Chikoo
Syn. *Achras-zapota* auct., non L.
Native of tropical America. It was introduced into India by the Portuguese in the 16th century. Cultivated for its fruit. The most important product of the tree is "chicle" gum which is used in the manufacture of chewing gum.

40. Ebenaceae

119. **Diospyros discolor** Willd. Mabolo
Native of Philippines (MacMillan 1952). Introduced into India in the early 18th century. Cultivated in gardens.

41. Apocynaceae

120. **Allamanda cathartica** L. Kampanilya
Native of tropical S. America. It was introduced into India from Guiana (Voigt 1845). Cultivated as an ornamental in private and public gardens.

121. **Catharanthus roseus** (L.) G. Don. Madagascar Periwinkle
This species might be native to America, especially West Indies; believed in recent years to have originated in Madagascar. Probably first introduced as an ornamental plant. Flowers rose-purple. Extensively planted in gardens, private bungalows, etc.

122. **Catharanthus roseus** G. Don. var. **albus** Sweet
An erect, pubescent subshrub. Flowers white. Planted in gardens in association with the former species.

123. **Plumeria rubra** L. forma **rubra** Frangipani Tree
Distributed from Mexico to Venezuela, Ecuador and West Indies. Introduced into India in 1841 (Voigt 1845). Cultivated in gardens, parks and lawns.

124. **P. rubra** L. forma **acutifolia** Woodson. Pagoda Tree; Temple tree
Indigenous to tropical America. Introduced into India in 1841 (Voigt 1845). Cultivated as an ornamental tree in gardens. Local name: *Gulanch*.

125. **Thevetia peruviana** (Pers.) K. Schum. Yellow Oleander; Cook Tree
Syn. *T. neriifolia* Juss. ex Miq.

Native of S. America. It is a great favourite of Hindus who offer its flowers to God Shiva. It was brought under cultivation in Europe in 1735 and since then distributed throughout the tropics as a showy, ornamental plant (Bor & Raizada 1954). It might have been introduced into India about 1795. Commonly planted in hedges.

126. **Trachelospermum jasminoides** Lem. Chinese Star Jasmine
Syn. *T. divaricatum* K. Schum.

Indigenous to China and Japan (Bor & Raizada 1954). It was introduced into Europe from Shanghai by Robert Fortune and came to India in the 17th century. Cultivated in gardens as a creeper on walls and trellises.

42. Asclepiadaceae

127. **Cryptostegia grandiflora** R. Br. Rubber Vine

Native of Africa (Bailey 1949). A climbing shrub. Flowers lilac-purple. Planted in gardens.

43. Boraginaceae

128. **Heliotropium indicum** L.

This species is probably of American origin (Reed 1964). It was introduced into the Old World about 1500 A.D. in ballast or baggage (Merrill 1954). Common in muddy soils, waste lands and periodically desiccating pools and ditches.

44. Convolvulaceae

129. **Convolvulus arvensis** L. Wild Morning-Glory; Lesser Bindweed

Native of Europe and Continental Asia (Backer & Brink 1965); now widespread in subtropical and tropical regions. Common as a weed in cultivated fields during the winter season.

130. **Ipomoea batatas** (L.) L. Sweet Potato

Native of Brazil; introduced into India by the Portuguese in the early part of 16th century (Watt 1890). Commonly cultivated for the edible tubers.

131. **I. fistulosa** Mart. ex Choisy.
Syn. *I. crassicaulis* Robins

Native of South America; probably introduced into India about a century ago by the Agri-Horticultural Society, Alipur, Calcutta. It was known under cultivation in Indian Botanic Garden, Sibpur, Calcutta during the year 1879. It grows extensively along the water courses,

ponds and ditches, roadsides, railway sidings, etc. and is used as a hedge. Local names: *Thethar ka phool; Amri.*

132. **I. nil** (L.) Roth.
Syn. *I. hederacea* auct. non. Jacq.
Native of Tropical America. A twining hairy annual with blue or light purple flowers. Grown as an ornamental along the trellises and walls of gardens.

133. **Volvulopsis nummularia** (L.) G. Roberty.
Syn. *Evolvulus nummularius* L.
Native of Tropical America (Roberty 1952). Introduced into India during the last part of the 18th century. Bressers (1951) first recorded it from Ranchi. Frequently found in waste lands, fallow fields, etc.

45. SOLANACEAE

134. **Brunsfelsia americana** L.
Native of West Indies (Backer & Brink 1965). Introduced into India in 1841 (Voigt 1845). Occasionally found in gardens as an ornamental annual.

135. **Capsicum frutescens** L. Chilli; Spur Pepper; Chile Pepper
Syn. *C. annuum* L. var. *frutescens* (L.) Ktze.
Native of tropical America. Mehra (1966) mentioned: "Bontius (1631) thought that it was carried from S. America to Indian Archipelago and thence to India (Yule & Burnell 1886). The Portuguese brought the plant to India from Pernambuco, according to Clusius (Dymock *et al.*)". Commonly cultivated for its fruits.

136. **Cestrum nocturnum** L. Lady-of-the-Night
It is an American contribution to Oriental gardens. Widely cultivated for its fragrant flowers at night.

137. **Lycopersicon lycopersicum** (L.) Karsten. Tomato
Syn. *L. esculentum* Mill.
Native of W. S. America (Bailey 1949). It was known in cultivation in W. Europe by 1561 (Stafleu 1969). Extensively cultivated for its fruits.

138. **Nicotiana plumbaginifolia** Viv.
Native of tropical America; introduced into India quite early, probably during 1824-1845 (Goodspeed 1954; Srivastava 1964). It spreads from Bengal towards the west and later in the northern regions. A common weed in cultivated fields, roadsides, etc.

139. **Physalis minima** L. Wild Gooseberry

Native of S. America. It spreads through cattle, birds and horse dung, and was introduced into India during the 17th century from Malaysia (Ridley 1930). Occurs as a weed in waste lands and fallow fields.

140. **Solanum tuberosum** L. Potato

Native of the Andean highlands of South America. It was introduced into Europe in 1570 and came to India in the later part of 16th century (Mehra 1966).

46. Scrophulariaceae

141. **Antirrhinum majus** L. Snapdragon

Native of S. Europe, Syria and N. Africa (Backer & Brink 1965). According to Gupta and Marlange (1961), it was introduced into India in 1886. It is a popular annual for outdoor beddings and edgings.

142. **Calceolaria mexicana** Benth. Common Slipper Flower

Native from Mexico to the Andes of Peru and Chile (Bailey 1949). It was introduced into India during 1845-1890. Grown in gardens.

143. **Mecardonia dianthera** (Swartz) Pennell.

Syn. *Herpestis chamaedryoides* H. B. & K.

Native of tropical America and recently introduced into India. It was recorded for the first time from Bengal by Prain (1903). Bressers (1951) first reported it from Ranchi. A weed in lawns, gardens and paddy fields.

144. **Scoparia dulcis** L. Sweet Broomwort

Native of tropical America; now spread throughout the Old World tropics. Common in moist waste lands, cultivated in paddy fields, etc. Local name: *Ipid-piong.*

47. Bignoniaceae

145. **Jacaranda mimosifolia** D. Don. Jacaranda

Syn. *J. ovalifolia* R. Br.

Native of Brazil and N. W. Argentina (Maheshwari 1963). It was introduced into India in 1841 (Voigt 1845). Planted in parks and gardens.

146. **Kigelia pinnata** DC. Sausage Tree

Native of Africa (Bailey 1949). Flowers scarlet-coloured. Fruits grourd-like, hanging on cord-like stalks. Planted in gardens.

147. **Tecoma stans** (L.) H.B. & K. Yellow Elder; Yellow-Bells

Native of Tropical America. Commonly planted in the hedges of gardens and also found as an escape.

48. Martyniaceae

148. **Martynia annua** L. Tiger's Claw; Devil's Claw

Native of tropical America; introduced into India before 1843 and now well naturalized. It spreads by the attachment of its hooked fruits to goats, sheep, etc. (Ridley 1930). Common on rubbish heaps, in waste lands and roadsides. Local name: *Budi Rama.*

49. Acanthaceae

149. **Thunbergia erecta** T. Anders. Bush Clockvine

Native of tropical America (MacMillan 1952). It was introduced into India in 1899 from Kew (Bor & Raizada 1954). Cultivated in gardens.

50. Verbenaceae

150. **Clerodendrum philippinum** Schauer. Nassau-Rose; Glorybower

Syn. *C. fragrans* Hort. ex Vent; *C. japonicum* var. *pleniflorum* Mahesh.

Native of China (Bruhl 1908). Extensively cultivated in gardens and well naturalized in tropical areas.

151. **C. thomsonae** Balf. f. Bleeding Heart; Thomson Glorybower

Native of tropical Africa (Backer & Brink 1965). It was introduced into England (Balfour, Edinburgh) in 1861 by a missionary from Old Calabar on the west coast of Africa and came to India about 1876 (Bor & Raizada 1954). Cultivated in private gardens.

152. **Duranta repens** L.

Syn. *D. plumieri* Jacq. Pigeonberry; Golden Dewdrop

Native of S. America and West Indies (Maheshwari 1963). Commonly planted in gardens and hedges.

153. **Lantana camara** L. var. **aculeata** (L.) Moldenke. Spiny Lantana; Planter's Curse

Syn. *L. aculeata* L.

Native of America (Backer & Brink 1965); introduced in the Calcutta Botanic Garden in 1809. According to Ridley (1930), it was introduced as an ornamental plant and was first recorded from Ceylon in 1824. Widely cultivated and common as a weed in forest clearings, cultivated fields and waste lands. Local name: *Poostu.*

154. **L. trifolia** L.

Syn. *L. indica* Roxb.

Widely distributed throughout tropical America (Moldenke 1955);

introduced into India at an early time. Bressers (1951) first reported it from Ranchi. Occasionally found in waste lands.

155. **Lippia alba** (Mill.) N. E. Br. ex Britton & Wilson.
Syn. *L. geminata* H. B. & K.; *Lantana alba* Mill.

Widely distributed throughout the West Indies, Mexico, Central America, tropical and subtropical South America to Argentina and introduced elsewhere (Moldenke 1955). Frequently found in marshy lands and moist situations.

156. **Petrea volubilis** L. Purplewreath Retrea

Native of tropical America (Maheshwari 1963). It was introduced into India in 1841 (Voigt 1845). Cultivated in gardens.

157. **Stachytarpheta jamaicensis** (L.) Vahl. Jamaica False Valerian
Syn. *S. indica* Vahl; *Verbena jamaicensis* L.

Native of America (Moldenke 1955). Introduced into India in the early 19th century. It escapes from cultivation and has become a pest in the vicinity of Ranchi. Local name: *Sitir-kar.*

158. **S. mutabilis** (Jacq.) Vahl. Variable False Valerian

Native of tropical America; introduced into India in the last part of the 18th century for the medicinal properties of its leaves which are applied to wounds and sores.

51. Lamiaceae (nom. alt.: Labiatae)

159. **Hyptis suaveolens** (L.) Poit. Ganga-Tulsi

Native of S. America; found throughout Africa and Asia (Epling 1936). It was introduced into India during 1872-1897 when Hooker published his Flora of British India. Occurrs as a weed in waste lands.

160. **Salvia coccinea** Juss. Red Salvia

Widely distributed in tropical America. Commonly cultivated as an ornamental in gardens under the name "Salvia" and "Scarlet Sage". Flowers scarlet in erect, lax spikes.

52. Nyctaginaceae

161. **Bougainvillea glabra** Choisy. Bougainvillea

Native of Brazil. It was introduced into England in 1860 from Brazil by way of Mauritius and thence into India during 1884-1894 (Bor & Raizada 1954). Commonly cultivated as an ornamental in private and public gardens.

162. **B. spectabilis** Willd. Hairy Bougainvillea

Native of Brazil. Introduced into India from England during 1860 (Bor & Raizada 1954). Commonly cultivated in gardens.

163. **Mirabilis jalapa** L. Four o'clock; Marvel-of-Peru

Native of tropical America (Webb 1964). Dymock *et al.* (quoted in Mehra 1966) mentioned as follows: "Five varieties of this plant with red, white, yellow, red and white, and red and yellow flowers were introduced from the West Indies in 1596 and these must have been carried by the Portuguese to the East shortly afterwards, as the plant is said to have been introduced into Persia in the reign of Shah Abbas, the First, and was established on the Malabar coast in the time of Van Rheede." Cultivated as an ornamental plant.

53. Amaranthaceae

164. **Alternanthera paronychioides** St. Hil.

Native of South America and West Indies. Introduced into India during the 20th century. Common in moist situations.

165. **A. philoxeroides** (Mart.) Griseb. Alligator Weed

Native of S. America; probably Brazilian in origin. Introduced into India during recent years and has been collected from Ranchi Lake (Maheshwari 1964).

166. **Gomphrena celosioides** Mart. Gomphrena-Weed

Native of South America. Introduced into India recently (Srivastava 1964). Found in waste lands and along roadsides. Local name: *Garundiara.*

167. **G. globosa** L. Globe Amaranth; Bachelor's Button

Probably native of America, but was originally described from India. Cultivated and naturalized in tropical regions. Common in gardens and often found as an escape in waste lands.

54. Polygonaceae

168. **Antigonon leptopus** Hook. & Arn. Coral Creeper

Native of S. America. Commonly planted in gardens, along trellises, poles and pergolas.

55. Aristolochiaceae

169. **Aristolochia elegans** Mast. Calico-Flower

Native of tropical America (Maheshwari 1963). It was introduced into India in the early part of 18th century. Grown as an ornamental climber in gardens and hedges.

56. Piperaceae

170. **Peperomia pellucida** (L.) H.B. & K. Shiny Peperomia

Native of Central America; introduced into India in the later part

of 19th century (Srivastava 1964). Bressers (1951) first reported it from Ranchi. Rarely found in waste lands; often grown in conservatories and ferneries.

57. Proteaceae

171. **Grevillea robusta** A. Cunn. ex R. Br. Silky-Oak; Silver Oak

Native of Queensland and New South Wales (Maheshwari 1963). It was introduced into Ceylon in 1856 (MacMillan 1952); occasionally planted in gardens, lawns and avenues. It has been recently introduced at the Indian Lac Research Institute, Namkum (Ranchi) as an ornamental tree.

58. Euphorbiaceae

172. **Acalypha wilkesiana** M.-A. Copper Leaf

Native of New Hebrides and the Viti Island. Often planted in parks and gardens as an ornamental shrub.

173. **Croton bonplandianum** Baill.

Native of South America. According to Ridley (1930), it was first introduced into Chittagong (East Pakistan) in 1897 with ballast of mud. Common as a weed along roadsides, railway lines and waste lands. Local name: *Puttri; Kutti.*

174. **Euphorbia geniculata** Orteg.

Native of tropical America. It was introduced into India before Hooker published the flora of British India. Found as a weed in gardens, nursery beds and waste lands.

175. **E. prostrata** Ait. Red Caustic Creeper

Native of tropical America; introduced into India early in the 19th century. It was first recorded in Bihar by Woodhouse (Srivastava 1964) from Sabour and later recorded by Bressers (1951) from Ranchi. Common as a weed in gardens and waste lands.

176. **E. pulcherrima** Willd. ex Klotz. Poinsettia; Christmas Flower
Syn. *Poinsettia pulcherrima* R. Grah.

Native of Central America. It is the Poinsettia of local gardens and florists. Commonly planted in gardens.

177. **Jatropha curcas** L. Physic Nut

Native of tropical America (Backer & Brink 1963). Dymock *et al.* (quoted in Mehra 1966) mentioned that it was introduced into India by the Portuguese. Commonly planted in gardens and hedges. Local name: *Totuka.*

178. **J. podagrica** Hook. Tartogo Nettlespurge

Native of Panama; introduced into India by the Portuguese. Planted in private gardens.

179. **Manihot esculenta** Crantz. Cassava; Tapioca-Plant; Manioc

Native of tropical America. It is said to have been introduced into India variously, viz. (i) by the Portuguese, (ii) by the Dutch from the East Indies into Ceylon and India, and (iii) through Spanish influence into the Philippines from where it appears to have passed into Burma, Assam, E. Bengal and other places (Mehra 1966). Cultivated for the starchy tubers which yield tapioca.

180. **Ricinus communis** L. Castor Bean

Its original home, according to De Candolle (1886), is in Abyssinia, Sennaar and Kordofan. Backer and Brink (1963) regard it as an ancient plant of cultivation, probably from Africa. It was introduced into India at an early time. Planted near villages and in gardens; often self-sown.

59. Casuarinaceae

181. **Casuarina equisetifolia** J. R. & G. Forst. Horsetail-Tree; Australian Pine

Its chief centre of distribution is Australia, Malaysia and the Pacific Islands. It was introduced in 1798 in the Calcutta Botanic Garden (Santapau 1965). Cultivated in gardens for decorative purposes.

60. Musaceae

182. **Ravenala madagascariensis** Sonn. Travellers-Tree

Native of Madagascar. It was introduced into Ceylon about 1824 (MacMillan 1952). Planted in gardens.

61. Cannaceae

183. **Canna flaccida** Salisb. Canna

Native of tropical America. Planted in beds as an ornamental shrub.

62. Amaryllidaceae

184. **Amaryllis belladonna** L. Belladona Lily

A tropical American species; introduced into India in 1808 and again in 1841, but has not flowered till 1845 (Voigt 1845). Occasionally grown in gardens.

185. **Haemanthus coccineus** L. Blood-Lily

Native of S. Africa. Introduced into India in March 1841, but did not flower till 1845 (Voigt 1845). Cultivated in gardens.

186. **Zephyranthas grandiflora** Lindl. Crocus

Native of Cuba, Jamaica and Mexico (Bailey 1949). Flowers rose-red or pink. Planted in pots, window gardens, etc.

63. IRIDACEAE

187. **Gladiolus gandavensis** Van Houtte. Breeders Gladiolus

Native of South Africa (Bailey 1949). This hybrid was raised by the nurseryman Van Houtte in 1841 (Fletcher 1969). Rare; cultivated in private gardens for its flowers.

64. PONTEDERIACEAE

188. **Eichhornia crassipes** Solms. Water Hyacinth; Terror of Bengal; Million Dollar Weed; Devil's Lilac; Morgan's Folly

Native of Brazil; introduced into the Old World about 1829. It was brought by a gardener in Dacca towards the end of the 19th century and has been carried all over India. Common in ponds, ditches and swamps.

65. COMMELINACEAE

189. **Rhoco spathacea** (Sw.) Stearn. Boat-Lily

Syn. *R. discolor* Hance.

Native of Central America (MacMillan 1952). Introduced into India in the 16th century. It is the so-called *Tradescantia* of gardeners and florists. Cultivated as a pot plant in green-houses and gardens.

190. **Zebrina pendula** Schnizl. Wandering Jew

Syn. *Tradescantia zebrina* Hort. ex Loud.

A native of Mexico (Bailey 1949). Cultivated for its foliage in hanging baskets, pots, tubs and beddings.

66. ARECACEAE (nom. alt.: Palmae)

191. **Livistona chinensis** R. Br. ex Martius. Tub Palm

Native of E. Asia and Malaysia. Introduced into India during 1795-1809. Commonly planted in private gardens as a tub-plant.

67. POACEAE (nom. alt.: Gramineae)

192. **Aristida adscencionis** L. Sexweeks Threeawn

A native of North Africa. According to Ridley (1930), it was described by Plukenet in 1696 as a Madras plant and was introduced into India prior to this date. Common in waste lands.

193. **Brachiaria brizantha** (Hochst. ex A. Rich.) Stapf. Signal Grass; St. Lucia Grass

Introduced into India in the early 19th century from tropical Africa as a fodder grass (Bor 1960). Cultivated in the premises of Agriculture College, Kanke near Ranchi.

194. **Chloris barbata** Sw.

Native of tropical America; introduced into India about 1897 or in the early part of the 19th century as a fodder grass. Cultivated at Kanke near Ranchi.

195. **C. gayana** Kunth. Rhodes Grass

It has been introduced into India from Africa in the early 19th century (Bor 1960). Commonly cultivated as a fodder grass.

196. **Cynodon plectostachyus** (K. Schum.) Pilger. Giant Star Grass

A native of Africa (Bor 1960); introduced into India as a fodder grass in the early 19th century. Cultivated in the Agricultural Farm, Kanke, near Ranchi.

197. **Eragrostis curvula** (Schrad.) Nees. Weeping Love Grass Syn. *Poa curvula* Schrad.

Native of Africa; introduced early in the present century. Cultivated in Ranchi as a fodder grass.

198. **Melinis minutiflora** P. Beauv. Molasses Grass

A native of Africa (Bor 1960); introduced into India as a fodder grass about 1892. Cultivated in Kanke, near Ranchi.

199. **Panicum coloratum** L.

A tropical American species; introduced into India (Bor 1960). Frequently cultivated.

200. **P. maximum** Jacq. Guinea Grass

A native of tropical Africa but now introduced into several warm countries including India (Bor 1960). Cultivated at Agricultural Farm, Kanke as a fodder grass.

201. **Paspalum notatum** Fluegge. Bahia Grass

An American species; introduced into India quite recently (Bor 1960). A good soil binder; cultivated at Agricultural Farm, Kanke.

202. **P. plicatulum** Michx. Brownseed Paspalum

Distributed in Georgia and Florida to Texas (U.S.A.), southwards through Brazil to Argentina and through West Indies (Bor 1960). Introduced into India quite early in this century. It has been found to be slow growing, susceptible to frost and seed setting is not satisfactory. Cultivated at Kanke.

203. **Pennisetum clandestinum** Hochst. ex Chiov. Kikuyu Grass

Native of tropical East Africa (Bor 1960); introduced into many

countries including India as a pasture grass and a soil binder. Cultivated at Kanke.

204. **P. purpureum** Schumach. Napier or Elephant Grass

A native of tropical Africa (Bor 1960); now introduced into many tropical countries including India. Commonly cultivated as a fodder grass.

205. **Phalaris tuberosa** L. Toowoomba, Canary Grass

Native of the Mediterranean region (Bor 1960); cultivated in Australia and India as a valuable pasture grass. Commonly cultivated in the area.

206. **Polypogon monspeliensis** (L.) Desf. Rabbitfoot Grass; Beard Grass

Widely distributed in Europe and temperate parts of Asia and Africa, and now introduced into many countries including India (Bor 1960). It is also found in cooler parts of northwest Himalaya and Ceylon. Commonly cultivated as a fodder grass.

207. **Setaria sphacelata** (Schumach.) Stapf

Native of tropical and South Africa (Bor 1960). Introduced into India recently as a fodder grass. Frequently cultivated at Kanke.

208. **Sorghum halepense** (L.) Pers. Johnson Grass

Snowden (quoted in Bor 1960) considers it as a native of tropical America. Introduced into India at an early time. Common as a weed and also used as a fodder.

209. **Urochloa mosambicensis** (Hack.) Dandy

A native of East Africa and Burma (Bor 1960). Introduced into India quite recently as a fodder grass. Cultivated in the plots of Agricultural College, Kanke.

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Reviews

1. FORCED MOVEMENTS, TROPISMS & ANIMAL CONDUCT. By Jacques Loeb. pp. xxvii + 209 (20 × 13.5 cm), with 42 text-figures. New York, 1973. Dover Publications, Inc. Price $ 3.00.

Jacques Loeb is chiefly known today as a biochemist. Few people are aware that he was one of the founders of the modern science of animal behaviour. Loeb's careful experimental work disproves the anthropomorphic views of his time, when it was believed that lower organisms were capable of exercising judgment when they avoided unfavourable conditions or were attracted to favourable ones. T. H. Huxley had already pointed out the fallacy in this kind of thinking, but it was Loeb who demonstrated the mechanical nature of the behaviour of lower organisms, and provided an explanation which covered his own observations and those of others. The attraction of certain insects to light, or to shade, can be attributed to changes in muscle tension induced by light falling on the eyes of each side of the body. When one eye is blackened with paint the insect creeps in circles because the tension on both sides is unequal. Loeb called such movements "forced movements" and sought to explain all animal behaviour in these terms. In his book he deals with heliotropism, or behaviour in relation to light, in most detail, but also deals with chemotropism, galvanotropism, and others. He points out that the growth of plants and of certain hydroids shows the same response to the action of gravity (geotropism).

Loeb's work has been forgotten mainly because interest has since shifted to the role of learning in behaviour a phenomenon not adequately covered by his theories. While Loeb perhaps tried to explain too much in terms of tropisms, there is no doubt of the basic correctness of his approach. This reprinting of his book, originally published in 1918, is very welcome, since it gives students the opportunity to appreciate his contribution to the subject, and to re-assess its significance in the light of later work. The foreword by Professor Hirsch of the University of Illinois puts it in perspective and adds to the value of the book.

R. R.

2. UNDER THE INDIAN OCEAN. By Al J. Venter. pp. 219 (27.5 × 21.5 cm), with 23 coloured plates and many black-and-white illustrations. U.K., 1973. Nautical Publishing Company Ltd. Price £ 5.00.

Not only is it fashionable to establish National Parks but it is becoming more of a necessity these days. In 1968, Kenya was perhaps the first country to create a Marine National Park with a view to preserve or rather conserve the coral and the marine life regarded as the best to be found anywhere in the East Coast of Africa. Al J. Venter has described the establishment of this wonderful park in his book.

UNDER THE INDIAN OCEAN can perhaps best be described as glimpses on the marine life and biology of the Western Indian Ocean. He has successfully created a unique atmosphere for people of diverse interests such as skin-divers, under-water photographers, conchologists, scientists and the laymen, who by reading this book will not only pick up a great deal of information but enjoy it as if they themselves were going through this vast Marine Park, the Indian Ocean and loving the nature below the waves.

Mr. Venter who is a professional journalist and a skin-diver of considerable skill has not only written wonderfully well but obtain many internationally known authorities to join hands in putting across their experiences in some of the specialist fields, for instance, George Hughes on loggerhead turtle (*Caretta caretta*), late Professor JLB Smith on Ichthyology, and Lallie Lee Didham on shells.

The most absorbing thing about the book being the anecdotes and description of the adventures undertaken by the skin-divers to view things of interest under the least known of our oceans. The book is fully illustrated with both colour as well as black and white pictures. The details of marine life obtaining in Seychelles, Mauritius, in the coastal waters stretching right from South Africa to Kenya including Madagascar are generously dealt with. Separate chapters have been devoted to turtles, dolphins, stone fish, sharks, coelacanth (a fish supposed to have become extinct 80 million years ago but live specimen of which were caught) and ship-wrecks and their treasures. It is partly a journey into adventure-land.

A pitty that Lakshadweep and Andaman and Nicobar Islands which are equally endowed with interesting wonders of the blue are conspicuously absent.

The book is very readable and I would recommend it to everyone interested in marine life as well as adventure under the Sea.

R. N. GULATI

3. TURTLES OF THE NORTH-EASTERN UNITED STATES. By Harold L. Babcock. pp. 105 (21 × 15.5 cm), with 16 plates including 14 in full colour. New York, 1971. Dover Publications, Inc. Price $ 2.50.

In this book, a reprint publication, the author has compiled available information on the life-histories of seventeen species of the Order Testudinata of North Eastern United States. The differences between a 'Turtle' (inhabitant of the sea), a 'Terrapin' (of fresh water) and a 'Tortoise' (inhabitant of the land) are explained and made understandable to the layman by simple anatomical descriptions. The morphology of the various testudines, their habits and habitats and geographic distribution are discussed.

The fascinating accounts of the breeding habits of many of the testudines inspires one to collect such details for the testudines of one's own region, which appear to have been neglected hitherto compared to their counterparts in the United States of America.

The book is an attempt to acquaint the reader, particularly the younger generation with the ecology and ethology of the different species of testudines and their economic importance. The book is well written and the plates, both coloured and monochrome, are very well produced and instructive.

SHAILAJA S. SOMANE

4. SUMMER OF A MILLION WINGS: Arctic Quest for the Sea Eagle. By Hugh Brandon-Cox. pp. 184 (21 × 14.5 cm). Illustrated with phoetographs and sketches by the author. Newton Abbot, 1974. David & Charles. Price £ 3.50 net.

The author has made several long expeditions to the Lofoten Islands in the north of Norway for filming and study of the wildlife there. The two small islands of Vaeroy and Rost have received his special attention as they are the summer nesting sites of millions of sea birds such as razorbills, puffins, kittiwakes, guillemots, skuas and others. Here his particular quest was to track down occupied nests of the Whitetailed Sea Eagle (*Haliaeetus albicilla*) once common, but whose numbers have now dwindled to danger levels chiefly due to human persecution for alleged wrong-doing. Enormous numbers of sea eagles used to be trapped on Vaeroy during the 1880s and 90s when one old trapper could take as many as 50 to 100 birds in the short period between October and December. He received two shillings as subsidy for each bird destroyed, and made one shilling extra by selling the wing feathers "which made excellent brooms"! Not till the subsidy was withdrawn did the killings decrease. Egg-collectors paid handsome prices for the eagles' eggs. In adjoining Sweden considerable infertility of eggs and lethal thinning of shells, resulting from extensive use of DDT had fur-

ther aggravated the position. Owing to ill-founded objections from sheep farmers, however, no legal protection was provided to the eagles in Norway till 1968, by which time eagle populations had dwindled almost to vanishing point. The author recounts a backbreaking expedition that he undertook to locate an occupied eyrie which nearly ended fatally for him while going up a sheer slippery cliff rising out of the sea, laden with heavy equipment. Good descriptions are given of these rugged rocky islands which, till comparatively recently, were thinly populated by a few tough fishing families but are now practically deserted, leaving the cliffs undisturbed for the nesting of millions of sea birds. The nesting behaviour of the various species in interestingly described, especially the tribulations of the young birds on the exposed ledges of the precipitous cliff faces or in fissures and hollows among the loose-piled rocks. The special adaptations which enable them to brave the harshness of the elements and overcome the hazards from avian predators—chiefly Blackbacked Gulls and Ravens—and culminating in their vertical descent to the sea where they will spend most of their non-breeding lives and face a different set of hazards. He gives a graphic account of the arrival of the birds on the cliffs in early spring as soon as the worst of winter is over, the occupation of the traditional nesting sites by each species, their reactions to neighbours, and the rivalries and social intercourse between members of their own and other species. Black guillemots are said to be tough and silent, not constantly clamorous like kittiwakes. They take fish from reed-filled water by diving to a depth of 25 feet or more. Thousands of kittiwakes are killed by villagers along the Newfoundland coastline, their flesh being preferred to that of all other birds. In overhead flight razorbills' wings produce a high screaming sound "exactly like a projectile fired from a cannon". The Raven population of the great cliffs apparently does not vary year to year in spite of each pair successfully raising batches of 5 young to a nest! There is a good account of puffins of which Vaeroy is said to be one of the greatest strongholds in the north. These curious birds nest in holes tunneled in a mixture of broken rock and earth with their massive flattened bills used as shovels. They live and fly in huge swarms "a whirring mass of wings". Non-breeding and immature birds assist in the 40-day incubation of the single egg. Mention is made of the "Puffin Hound"—a dying race of ancient hunting dogs, unique in the possession of six toes—which hunt and retrieve puffins from their steep nesting slopes on the island. They are regarded as relics of the Ice Age and as probably the rarest dogs in the world today.

This is an interesting book giving a good overall picture of the bird life and the rigorous living conditions in the Land of the Midnight Sun.

S. A.

5. DEER OF THE WORLD. By G. Kenneth Whitehead. pp. xii + 194 (24.5 × 19 cm) with colour frontispiece, 32 pages of black and white photographs and 27 maps. London, 1973(?) Constable & Co. Ltd. Price £ 5.00.

The last review of the family Cervidae was by Lydekker in 1898. A re-appreciation was necessary and has been ably handled by Kenneth Whitehead. The family with forty species of seventeen genera currently recognised is distributed indigenously or through introduction by human agency throughout all the regions of the world. Like all other wild life, several species face severe stress from human interference in their environment. Many of the species in the more populated areas of the world face extinction. The review is therefore timely.

The book has introductory chapters on the family followed by a regionwise study of the species, and includes a useful appendix on the classification of the Cervidae and a bibliography of works referred to in the preparation of the book.

One looks for familiar faces in such a compilation and while the treatment of Indian Deer is uniformly satisfactory, the information on their present status has to be updated. For instance is is unlikely that there are 300-400 Hangul still in existence. A useful handbook for all those interested in the Deer of the World.

J. C. D.

Miscellaneous Notes

1. A NOTE ON THE HOOLOCK

Village Chanki is half way between Moryani, the road-head for Jore-hut (Assam) and Mokok Chunge in Nagaland. It was about 8 a.m. when we stopped at Chanki, near a way-side tea stall for a cup of tea. As we were having tea, the loud call of Hoolocks came floating down the valley. There was a pattern in the call, first a single call would be heard and then more Hoolocks join in the chorus and the calls grow intense until they reach a crescendo and stop. The troup was quite close to the main road and therefore, within 20 minutes walking distance. I was able to get fairly close to the spot where the apes were. They were all in the higher branches distributed among three trees at the bottom of the valley. Taking a slightly elevated position on the other side, I was able to watch them comfortably with field glasses.

The female Hoolock spotted me and the whole troup moved further up. The calling stopped. Two males were engaged in a sort of game chasing each other. They were using their legs with such dexterity that it looked as if they were moving with four limbs like some giant spider. The female was greyish brown and male jet black. Though I could spot the two Hoolocks swinging through the branches, I did not have the occasion to observe their brachiation.

Back in Shillong where I was stationed at the time, I began to enquire about the distribution of this Hoolock. In Meghalaya itself, they have been spotted at Bagmara in Garo hills, Lailad near Nongpoh and Nia Bangla in Kasi hills. The Kasis of Meghalaya referred to this ape as 'Huleng' which I gathered is an onomatopoetic name.

B 49, 9TH CROSS, S. THEODORE BASKARAN
SASTRI NAGAR,
MADRAS 600 020,
June 13, 1973.

2. URINE OF BATS AS MEANS OF OFFENCE

Dr. J. L. Harrison in an interesting note (*J. Bombay nat. Hist. Soc.* *56*(1):125, 1959) mentioned that flying individuals of an unidentified species of horse-shoe bat in Malaya gave out squirts of urine well directed towards the intruder and pointed out the possible importance of this habit in the spread of leptospirosis, an infectious disease of

man and animals transmitted through the urine. He was much interested in obtaining further information on the subject. I have observed similar habit in a number of species of bats as shown by the following observations:

1. Several individuals of a large colony of the Lesser Rat-tailed Bat, *Rhinopoma h. hardwickei* Gray in a rock cave observed in August and September near Jabalpur city started urinating a few minutes after my entry into the haunt. The urination was accompanied by frequent shifting and spreading of wings. There were several outlets and the individuals were not under fear of being captured. The colony was also quite used to human presence and did not disperse. I was at a distance of about 4½ m from the colony. The urination stopped as soon as the intrusion ended.
2. A large colony of the Blackbearded Tomb Bat, *Taphozous m. melanopogon* Temminck was observed in Mandla town (M.P.) in November in second storey of a ruined house. The ceiling was low, hardly 4 m high and I could approach the bats within a distance of about 2½ m. Several urinating individuals flew very near to me during my stay for about 45 mins. Similar observations have been made in some other places also.
3. A colony of the Indian False Vampire, *Megaderma l. lyra* Geoffroy inhabiting a ruined temple near Jabalpur city started urinating after about ten minutes of my presence inside the temple.
4. Fying specimens of the Lesser Yellow Bat *Scotophilus temmincki wroughtoni* Thomas have been observed to urinate on the observer. Drops of urine came out of captured specimens when they were roughly handled.
5. One of the flying specimens of the Greater Yellow Bat, *Scotophilus h. heathi* Horsfield when too closely watched at the time of return to its roost early in the morning gave out squirts of urine while flying near the observer.

The above observations show that the habit appears to be of quite common occurrence in bats.

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Jabalpur, M.P.,
September 4, 1971.

3. OCCURRENCE OF FISHING CAT (*FELIS VIVERRINA*) IN ORISSA

A young male of the Fishing Cat (*Felis viverrina*) was caught by some villagers near the village of Balarampur (Keonjhar district, Orissa) on 27-iv-1973 and the animal was received at Nandankanan

Biological Park on 27-iv-1973 through the good offices of Sub-Divisional Officer, Anandpur. However, it died soon after its arrival. The animal weighed 3.6 Kg and measured 83 cm from tip to tip including 23 cm long tail. This appears to be the first record of occurrence of this cat in Orissa.

An adult female Fishing Cat received in this Park on 26-vi-1967 through an animal dealer of Calcutta died on 2-iii-1974 after remaining for 6 years, 8 months and 5 days in captivity. The estimated age at the time of death was about 10 years. After death it weighed 6.8 Kg and measured 102 cm including 26 cm long tail. It was fed on a mixed diet of beef and mutton with a chicken once a month and used to take fish whenever offered. It had the peculiar habit of urinating most of the time into the water trough. It was very shy, and kept inside its shelter throughout the day coming out for feeding late in the evening when all the visitors had left and moving about in the enclosure from late evening to early hours of the morning.

Prater (1971)[1] gives the distribution as forests up to 1525 m in the Himalayas and the swamps at the base of the mountains. Parts of Bengal, Uttar Pradesh, and Sind and unknown in the Peninsula of India except in the creeks and backwaters of the Malabar coast between Mangalore and Cape Comorin.

VETERINARY ASSISTANT SURGEON,
NANDANKANAN BIOLOGICAL PARK,
P.O. BARANG, DIST. CUTTACK.

L. N. ACHARJYO

WILD LIFE CONSERVATION OFFICER,
OLD SECRETARIATE BUILDING,
CUTTACK 1 (ORISSA),
April 25, 1974.

R. MISRA

4. AGE OF SEXUAL MATURITY OF TWO SPECIES OF WILD CARNIVORES IN CAPTIVITY

In this note, an attempt is made to present some information on the age of sexual maturity of two species of wild carnivores observed at Nandankanan Biological Park, Orissa.

Tiger *Panthera tigris* (Linn.)

A female tiger cub with an estimated age of about 7 weeks was received in this Park on 2-xi-1967. She came into heat for the first time on 3-ix-1970 and was allowed to remain with a male tiger born

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[1] PRATER, S. H. (1971): The Book of Indian Animals, Bombay Natural History Society, Bombay: 74-75.

in the Park on 31-vii-1967. Mating was observed during the following periods, 3-ix-1970 to 5-ix-1970; 22-xii-1970 to 25-xii-1970; 2-iv-1971 to 6-iv-1971; 1-vi-1971 to 5-vi-1971; and 23-vii-1971 to 27-vii-1971. A female cub was born on 7-xi-1971. From these facts it can be said that while the first signs of sexual maturity in the female appeared at the age of about 3 years, the male did not reach sexual maturity at least one week before he reached the age of 4 years.

According to Prater (1971) lions and tigers take from 3 to 5 years to become fully adult but males and females are capable of breeding soon after, or even before, they are 3 years old. The first cubbing of a tigress takes place at about the age of four and a tiger is fully grown in about 5 years (Chaturvedi 1970). A female tiger became sexually mature soon after passing the age of $3\frac{1}{2}$ years whereas a male tiger became sexually mature at least 15 days before he reached the age of 4 years (Crandall 1965).

Common Palm Civet or Toddy Cat *Paradoxurus hermaphroditus* (Pallas)

A male common palm civet born in this Park on 3-iv-1971 was allowed to remain with its mother and mating of the young male with the female was first observed from 12-iii-1972 to 14-iii-1972 resulting in the birth of 3 young on 18-v-1972. From these facts the age of sexual maturity of the male common palm civet can be said to be not less than 11 months, 10 days or say 11 months.

The age at which the civets became fully adult is not known (Prater, loc. cit.).

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P.O. BARANG, DIST. CUTTACK.

WILD LIFE CONSERVATION OFFICER, R. MISRA
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CUTTACK 1 (ORISSA),
March 12, 1973.

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5. SOME OBSERVATIONS ON THE WILD DOG IN THE KANHA NATIONAL PARK

During my stay in the Kanha National Park, Mandla District, Madhya Pradesh, in connection with the study of wildlife from March, 1971 to March, 1972, some interesting unrecorded observations on the wild dog were made by me and are reproduced from my field diary.

On 11-vi-1971 at about 6.00 p.m. a wild dog was seen running towards a large tank called Srawantal. It was being followed by four jackals, three of which were at a distance of about 60-70 metres from the wild dog, while the fourth was close behind. The dog went straight to a fairly large herd of chital on the bank of the pond, and attacked a large (about 2-3 year old) stag. The dog caught hold of the chital's muzzle and during the struggle both moved into the water. The dog did not let lose its grip and the stag's muzzle was pushed under water. Within minutes, the chital died of suffocation. The dog dragged the dead chital towards the centre of the tank where it was left without any attempt to eat. The dog came out of water and trotted back in the same direction from which it had come. The observations were made from a watch tower and the dog did not detect the presence of the observer. It did not return to its kill till next morning when the chital was removed from the tank. The possible explanation for dragging the dead chital towards the centre of the water tank appears to be that it wanted to save the kill from the jackals.

On 21-vi-1971 at 6.20 p.m. an alarm call was given by a grazing herd of chital from the meadow close to the rest house. The cause of the call was a wild dog, and an yearling chital hind was soon caught and killed. As we moved towards the dead chital, the wild dog started running and we spotted another wild dog close by and both escaped into the forest. Another kill, a large chital stag, was spotted by us close to the one mentioned above. It appeared to have been made a day earlier, but had not been eaten.

Beside the above observations, I have observed a number of kills of chital and sambar made by wild dogs during my one year stay.

N. K. SINHA

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Jabalpur (M.P.),
August 29, 1973.

6. WHITETAILED EAGLES [*HALIAEETUS ALBICILLA* (LINN.)] AT BHARATPUR, RAJASTHAN

At about 1500 hrs on December 6th, 1973, SCM was sitting by the edge of a road overlooking the wetlands of the Bharatpur reserve, when two adult Whitetailed Eagles (*Haliaeetus albicilla*) came flapping over the trees and low over the water. The birds were watched for several minutes at a range of about 200 yards.

SCM returned about an hour later with PAD, MCR and CWW and the birds were then watched for about 20 minutes both sitting on low trees, on the ground and flying about.

They were massive eagles, with long, broad wings and very short wedge-shaped white tails, the short tail being almost hidden when the birds were at rest. In colour they were uniform dark brown with pale, buff-brown heads and necks. Tail pure white. The large bill was bright yellow, uniform with the cere and gape. Iris yellow. Legs and feet were naked and also bright yellow.

The birds were watched in the same place the following morning (7th) and again with Dr. Salim Ali on the morning of the 8th December 1973.

57, Tewkesbury Road, Carshalton, Surrey, U.K. — P. A. DUKES

82, Clarence Road, Torpoint, Cornwall, U.K. — S. C. MADGE

Oatlands, Iford, Lewes, Sussex, U.K. — M. C. ROBINSON

203, Town Lane, Ashford, Middlesex, U.K., — C. W. WESTWOOD

January 18, 1974.

7. A NOTE ON THE FEEDING OF THE SARUS CRANE *GRUS ANTIGONE ANTIGONE* (LINNAEUS)

Three Sarus cranes were seen feeding on the 24th January, 1974 at 4.45 PM in the Keoladeo Ghana Sanctuary at Bharatpur. One of them was a subadult, in all probability the half-grown *young* of the adult pair.

The subadult bird was approximately three-fourths the size of the adult feeding besides it. The head and upper neck were yellow ochre, in place of the red of the adult. It had a few grey plumes on the crown, which in the adults form a grey patch.

The young bird could not find food on its own. The adults plunged their heads into the water which was a few inches deep, and probed the bottom with their bills for food. The young merely took the food directly from the bill of the adult or picked the surfaced food and swallowed it. The food, as observed through an 8 x 30 binoculars was on most occasions a small dark mass, which could have been a small crab? The period of immersion of the head in the water by the adult sarus crane was timed. It was timed on twenty occasions and on most occasions it was five seconds. Only on two occasions did the time exceed five seconds, by two seconds.

I was also keen on finding out the percentage of success in finding food in that area, as that would give an idea of the abundance of food. On twenty separate bouts of searching for food one adult sarus crane came up with food on four occasions, a 20% success. The two adult birds took little respite from their effort at finding food and their heads used to be out of water for a very brief period of two to three seconds between each bout of five seconds of assiduous searching for food.

The Sarus Cranes were quite unperturbed by my presence only about twenty five yards away and continued to feed for half an hour, at the end of which they flew away on their own.

'VIKAS BHAVAN', AJAI M. GHORPADE
29-SANKEY ROAD,
BANGALORE-52,
April 22, 1974.

8. ON THE NESTING HABITS OF THE SMALL MINIVET (*PERICROCOTUS CINNAMOMEUS*)

While glancing through W. Jesse's *On the Birds of Lucknow, Ibis* 1902, p. 541), I was struck by the following note regarding the Small Minivet (*Pericrocotus peregrinus* now *cinnamomeus*):

"A most curious fact in connexion with this bird is that—with, I think, only one or two exceptions at the most—I have always found nests, whether building or with eggs, in possession of *three* birds, *two* females and one male. What is the exact duty of this second wife I cannot make out. Possibly she may be a drudge. That she exists I have satisfied myself time after time, and so convinced are the Martiniere (College—H.A.) boys of the fact that they—no mean observers by the way—rarely troubled to look for a nest if only one female is present".

He goes on to say that he does not think that they both lay eggs,

but cannot say whether they both share the incubation or feeding the young.

Stuart Baker in NIDIFICATION (1933, II, pp. 294 *et seq.*) has overlooked this though he quotes Inglis as having once found a young one and three *fresh* eggs in a nest, though the usual complement was three, and sometimes only two.

Here the matter lay until in 1950 K. K. Neelakantan (*JBNHS* 49 : 554) writing from Palghat, recorded a male and two females sharing the labour at a nest. Of the two females, one was more active than the other, but the second was seen to bring nesting material. About a month later, all three fed the *two* chicks in the nest.

The last note is referred to in INDIAN HANDBOOK (*6*:44) but the earlier note suggests that this habit is more wide-spread than generally realised and provides an excellent item for study in the field.

75, ABDUL REHMAN STREET, HUMAYUN ABDULALI
BOMBAY 400 003,
April 15, 1974.

9. ORNITHOLOGICAL RECORDS FOR PAKISTAN

During the past year I have been lucky to encounter several interesting new distributional records for different regions of Pakistan and feel that it is important to record these if only to indicate how much fresh information still has to be worked out for this country which has not been as intensively studied in the past few decades as has been the case in many parts of India.

Pluvialis dominica (Horsfield) Eastern or Lesser Golden Plover.

This has been recorded as wintering in India and Bangladesh (Ripley 1961) with no mention of what was then called, West Pakistan[1]. Vaurie also records only an eastern migration route to the Maldives, Ceylon and the southeast coast of India (Vaurie 1965). This is rather surprising in view of Dr. Ticehurst's records for the Karachi area (*Ibis*, October 1923, pp. 662).

I have only encountered it near the Indus mouth, generally on the east bank, and preferring the margins of drying-out swamps. It is one of the rarest waders visiting Sind in winter, but as it is usually encountered in small flocks, and its dark grey axilliaries are easily seen when in flight, it is not difficult to recognise in the field.

Rhipidura hypoxantha (Blyth) Yellowbellied Fantail Flycatcher.

This bird has been described as occurring in the Himalayas, in

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[1] But see HANDBOOK OF THE BIRDS OF INDIA & PAKISTAN *2*:223—Eds.

India from Kareri Lake near Simla, eastwards through Nepal, Bangladesh and Burma (Ripley 1961).

On December 6, 7 and 8, 1973 I was camping in the old municipal gardens of Sialkot Cantonment (32° 28′ N., 74° 33′ E.) and there were at least three individuals, (one obviously a female) frequenting the tree groves around these gardens. They were always seen feeding in trees and often in the company of the Greyheaded Flycatcher-Warbler (*Seicercus xanthoschistos*), another altitudinal winter migrant. A considerably smaller, and if possible, even more restless version of the Whitebrowed Fantail Flycatcher (*R. aureola*), they were nevertheless fearless of humans and very easy to observe. Though Sialkot is roughly two hundred miles northwest of Simla, perhaps its occurrence so near to the hills of Jammu is not surprising, but after twenty-three years residence in Pakistan, to see a new species, and one so gaudily attired was an especial thrill.

Terpsiphone paradisi (Linnaeus) Paradise Flycatcher.

In the "Newsletter for Birdwatchers", edited by Mr. Zafar Fatehally, I recorded in about 1966 the attempted breeding of this flycatcher in an irrigated forest plantation near Khanewal in the southwest Punjab. It is probably a not infrequent breeder in suitable forested regions of the Punjab because in May 1973, a pair attempted to breed in my own garden in Khanewal (30° 18′ N., 71° 56′ E.). This is at 600 feet above sea level and maximum daily temperature in early May is usually about 112°F. so these flycatchers would normally be only tarrying briefly on northward passage. We have a small swimming pool surrounded by shady trees and the female was first seen carrying nesting material on May 7th. Anxious not to disturb the pair, I did not discover the completed nest until May 12th! — *a grass-lined, sleeve-like structure* suspended in a hanging creeper. Unfortunately on May 19th, I had to go away on business and found the nest robbed upon my return. However I have several fairly good 300 mm telephoto lens picture of both parent birds sitting on the nest. Both sexes were extremely restless, never staying long to incubate. There were only two eggs at the time of my departure. The female generally came and perched on the nest rim to relieve the male and she usually sat from ten to fifteen minutes at a spell. The male never came to incubate except when the nest was unoccupied and never sat for more than ten minutes, usually only five. Both sexes frequently left the nest to chase after insects, even when incubating.

Sylvia mystacea Menetries's Warbler.

Perhaps this is also not such a surprising record for Baluchistan, in view of what is known about the species' migration routes and breeding range.

However, it is a new record for the sub-continent as it is not listed

in Stuart Baker's FAUNA OF BRITISH INDIA (1924) nor in Dillon Ripley's SYNOPSIS OF THE BIRDS OF INDIA AND PAKISTAN (1961). It is listed as a passage migrant and summer visitor for Afghanistan (Paludan 1959). He only secured one specimen in Seistan and considered it rare. Hue & Etchescopar (1970) give its distribution as, occurring across northern Afghanistan as a breeding species.

On March 23rd and 24th, 1974 during a visit to Baluchistan province and Pishin district, northeast of Quetta, I explored a relatively remote valley called Sorkhab, running roughly east west at 5,500 feet elevation and situated at 30° 33′ N., 67° 12′ E. The valley contains a small stony stream of flowing water (unusual in this arid part of the world), flanked by quite large willow trees, tamarisk scrub and thickets of *Phragmites* reeds. On one afternoon's walk I encountered at least eight different individuals of this species. Though typically Sylviine in their relatively furtive habits, they advertised their presence by continuously scolding "tchk-tchk-tchk" calls. The males also were frequently heard singing a very soft but melodious song which I recorded as being very similar to that of a Common Whitethroat's (*S. communis*). The males were remarkably like *C. cantillans*, the Subalpine Warbler in appearance (in fact this is what I assumed them to be at first), in that the upper breast was distinctly strawberry red or terra-cotta and both sexes had noticeable white loreal streaks. Moreover the males had dark grey rather than black crowns, napes and ear-coverts. The orbicular ring was fleshy orange and conspicuous in both sexes as also the white outer margins to the outer tail feathers.

The breasts of several females seen, I recorded at the time, as pinkish-buff, with one individual having a distinctly fulvous tone.

From their behaviour and numbers I would say that they were by no means accidental visitors but that this valley is regularly used on spring passage.

Prunella fulvescens (Severtzov) Brown Accentor.

In Pakistan, it is recorded as a winter visitor, occurring in the northern reaches of the Indus Valley in Baltistan, Hunza, Astor and northern Gilgit. Also in Chitral down to the main valley it has been recorded. However it is also generally encountered above 10000 feet elevation, even in these far northern areas. It apparently breeds in north-central Afghanistan at about 9000 feet elevation (Paludan 1959) and eastwards to Chinese Turkestan and Ladakh (Vaurie 1959).

During the same visit to Baluchistan (mentioned above) on March 30th, 1974, I visited the Mashelakh range in Quetta district, located about 30 miles northwest of Quetta at 6000 feet (30° 15′ N., 66° 34′ E.). This area is at least 300 miles south of previous records for Pakistan's Himalayan regions.

I encountered but one individual frequenting a dry bush-studded

gulley on a sloping plain. It perched conspicuously on bush tops fluttering periodically to the ground nearby to pick up food. It was tame and allowed continuous and close observation and appeared to be in quite bright fresh plumage though it is not possible to state whether it was a male or female. Looking at the coloured plate by Paul Barruel, of this species in "Les Oiseaux du Proche et du Monjen Orient", this Baluchistan specimen had more conspicuous black or dark brown streaking both on its crown and mantle whilst its throat was a yellow-buff or fulvous tone and the outer margins of the scapulars were pale creamy-buff. The broad supercilium was much whiter than that of either *P. strophiata* or *P. atrogularis* which have creamy-yellow superciliums. These latter species, with a more marked altitudinal migration pattern are more frequently encountered in Pakistan.

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10. A NOTE ON THE BIRD PREDATORS OF THE DEATH'S HEAD HAWKMOTH, *ACHERONTIA STYX* W.

The sphingid *Acherontia styx* W. is a polyphagus pest noted on sesamum, lab lab, brinjal, groundnut and jasmine. The caterpillar is a defoliator. Sesamum is badly effected especially during the months of September - November at Coimbatore with as much as 20% damage. However, the outbreak is often effectively checked by birds that feed on these fleshy caterpillars. The following are the birds that have been

observed preying on the caterpillars of *Acherontia styx* W. in sesamum fields.

Corvus splendens Vieillot, Common House Crow

This is the most effective predator and observed in the field throughout the day. The birds usually fly around the fields to locate the caterpillars and perch on any available support or walk around the bunds to pick the caterpillars. They pick up the half to full grown caterpillars while earlier instars usually escape. The birds identify the prey by the light movement of the caterpillars and the swinging of the twigs caused by the weight of the fleshy larvae. The predation can be effectively increased by providing bamboo stakes in the fields at random locations. It is interesting to note that these birds pick only the caterpillars of *A. styx* even though the caterpillars are often found with *Estigmene lactinea* and *Euproctis faterna* larvae and certain lygaeid bugs.

C. macrorhynchos Wagler, Jungle Crow

This bird is also an effective predator. However, they come in less numbers than *C. splendens,* and are seen more in the morning hours.

Turdoides caudatus (Damont) Common Babbler

These birds fed on earlier instars of this sphingid. The birds fly over and go deep into the field between the plants to pick the prey. The common babblers' nest was also been met with in the field.

Acridotheres tristis Linn., Common Myna

The common myna picks up the small earlier instars on the ground in the field. Their activity was more during the earlier hours of the morning, but visited the field throughout the day in small flocks of three to five. Their food, included grasshoppers and crickets.

Dicrurus adsimilis (Bechstein), Black Drongo or King Crow

These birds were also frequently noted every day. Two or three were seen perched on electric or telegraph lines over the field. They just plunged into the field and took away large sized sphingids. Besides the sphinx, this bird preys upon various other caterpillars and lygaeid bugs too. Other insectivorus birds included the green bee-eater, *Merops orientalis* Latham., the night-jar, *Caprimulgus asiaticus* Latham and the common palm swift, *Cypsiurus parvus* (Lichtenstein).

All these birds are very common (Fletcher and Inglis 1924; Salim Ali 1967) and are a good check to pests like *A. styx*.

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S. THIRUMURTHI
E. V. ABRAHAM

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11. A NOTE ON *TESTUDO HORSFIELDI* GRAY, THE AFGHAN TORTOISE OR HORSFIELD'S FOUR-TOED TORTOISE

Five hatchlings of this species were picked up in the summer of 1967 in Baluchistan. I have kept them on the earth floor of a rather spacious aviary in the Punjab, since that date.

Some of my observations on their behaviour do not appear to have been recorded hitherto.

Description

It is a relatively robust and purely terrestrial tortoise, distinguished from other species of the genus by having only four instead of five claws on the fore feet.

The tail in male specimens appears slightly longer than those of the females, and also the concavity in the posterior region of the plastron is more marked and clearer than is the case with females. However, I have not recorded sufficient measurements to substantiate this impression. In both sexes the tail terminates in a horny nail, which is again, slightly longer in that of the males.

The carapace is markedly flared along its posterior edges, so that its width at the broadest point, just anterior to the hind legs, is roughly ninety percent of its length. Minton (1966) records carapace length in adults from 170 mm to 208 mm. In March 1974 I came across two particularly massive specimens in the Sorkhab valley of Pishin District, Baluchistan. One, which appeared to be a female measured approximately 220 mm carapace length and the other was approximately 210 mm.

Distribution

Murray (1884) recorded them as occurring in the Lakhi Hills of Sind but there is no recent evidence of its occurance east of Baluchistan. It is still fairly plentiful in that Province, at elevations between 5000 up to 7000 feet. I have found it as low as 3000 feet in the Chagai District, near Anam Bostan. It extends northwards into southern Waziristan, specimens having been collected from Wano (Smith 1931). Elsewhere it occurs in Afghanistan, Kazakhistan in the USSR, and in northern Iran, westwards to the shores of the Caspian (Minton, op. cit).

Growth Rate

Minton (op. cit) records a hatchling given to him in August, having a carapace length of 51 mm. Three years later it had grown to

70 mm. I picked up a hatchling in March in Baluchistan, in which the plastron was still quite soft and pliable. It measured 50 mm carapace length and 46 mm width anterior to the hind legs. Another captive born hatchling (described below) measured 49 mm carapace length.

The five young tortoises which provided most of the data for this note measured from 56 to 58 mm carapace when given to me in October 1967. Having been picked up in Baluchistan during the earlier part of summer, I presumed them to be between three and six months old at that time. They are now eight years old and measure from 172 to 181 mm in carapace length. Growth in the intervening years certainly appeared more rapid to my casual observation, that I would have anticipated. A relatively generous diet, available in captivity, may not be significant since they are only active and feeding for about five months in a year.

Habits

My captive specimens bury themselves completely from about mid October until early March. I have recorded emergence on March 2 and March 15 in different years. Even when they are not in physical proximity (one individual having buried itself in a separate corner of the enclosure), it is significant that all five emerge within 24 hours of each other. Aestivation occurs throughout June, July and the early part of August (in the Punjab), even when plentiful drinking water and forage is daily provided.

During their active periods, they feed mostly in the early morning and late afternoon, partially burying themselves during the heat of the day under any convenient object. In the wild they burrow into old rodent holes or underneath overhanging stones. The many wild specimens I have encountered, appeared quite wary and they can move relatively quickly if they want to conceal themselves. They are capable of climbing very steep hillsides and move with their plastron carried well clear of the ground.

Breeding Behaviour

When they first emerge in March all the captive tortoises are very active roaming round and round their enclosure. It is believed that the males at this time are seeking females. I have often encountered two and three tortoises in close proximity during March, in Baluchistan. When they encounter another tortoise they approach it directly until a few inches away. Then withdrawing the head and neck, they almost run forward, and by raising the forelegs, endeavour to tip over the other tortoise. I observed this reaction when both males and females are encountered, but presumably females do not retaliate by attempting to push over their opponent, and this agonistic behaviour is the only manner in which the males determine the sex of the encountered individual (Carr 1968). I have seen tortoises successfully turned up-

side down on several occasions as a result of these "shoving matches" but was always surprised to see how the victim was able to obtain enough purchase with one wildly waving hind leg, to right itself unaided, especially if the ground was a little uneven. Frank Finn (1929) described similar behaviour in the Indian Starred Tortoise (*Testudo elegans*) though this has not previously been recorded for *T. horsefieldi* to my knowledge. It may well be a common courtship behaviour pattern with the genus.

The Starred Tortoise, a typically oriental faunal species, is sexually active at the onset of the rainy season in early August, whereas the Afghan tortoise confines its sexual activity to March so that this may be termed the rut season and is fairly typical of many hibernating Palaearctic mammals, also.

In their sixth year of age in late March, I observed attempted copulation, but no eggs were laid. In their seventh year, on March 22, 1973 I observed apparently successful copulation which lasted for about six minutes. The male stood almost vertically on his hind legs with the head and neck bent at right angles, and during this time he emitted faint but clearly audible squeaking noises at intervals of about half a second. This is the only occasion that I have ever heard vocalizations though Annandale in Smith (1931) remarks that "when eating or drinking, it occasionally emits a low croak like a frog".

By chance, I was home from the office in mid-morning on April 25 of the same year, when a female was observed digging a nest hole. She used only her hind feet, scrapping backwards with vigorous actions. When discovered, the hole was about five inches deep and practically completed. In it, she laid only two eggs. Each was surprisingly large (considering the size of the mother) and almost spherical. I did not measure these but estimated them to be fractionally under the size of a ping pong ball (which has a diameter of 35 mm). Dr. Minton (op. cit) gives the dimensions of one egg as 41 mm by 28 mm and Smith (op. cit) records a female killed, containing five fully formed eggs, which measured 50 mm by 35 mm. From the time of laying the first egg till covering and tamping down the excavation, took hardly twenty minutes. From these two eggs, which I made no attempt to disturb, one tortoise hatched on July 10, 1973 (76 days after egg laying). Unfortunately it appeared to have died of dessication when it was discovered by my Mali (gardener) two days later.

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12. THE OLIVE KEELBACK (*ATRETIUM SCHISTOSUM* RUSSELL) FEEDING ON MOSQUITO LARVAE

At the Madras Snake Park several local species of snakes are kept in a large natural-foliage enclosure surrounded by a 4 ft cement wall and moat. Frogs. mice and lizards are put in as food but the Olive Keelback supplements its diet by actively hunting and feeding on mosquito larvae, probably *Culex* sp., average length 10 mm. We observed 300 mm long keelbacks swimming slowly along the smooth, algae choked bottom and sides of the water moat. Occasionally lowering or bending its head to the side while swimming, the snake disturbed the algae and invariably several larvae would shoot out in their odd jerky way. The Keelback would then grab at the larvae with its characteristic sideways bending jab we have observed it using on frogs. The larva is swallowed with a few quick 'chews'. One specimen observed continuously for 25 minutes caught an average of 17 larvae per 5 minute period and we estimated that only 10% of the snake's jabs were failures. Larger specimens (i.e. females) have not been observed catching larvae.

Considering bio-mass, this feeding behaviour seems a bit impractical. There are other snakes which regularly feed on invertebrates but usually it is of a more logical size relationship, for instance, the Saw-scaled Viper (*Echis carinatus*) feeding on the large black scorpion *Heterometrus* sp. The snakes observed were not in an emaciated state so we consider this to be the normal feeding behaviour of the Olive Keelback, exhibiting a modified frog hunting technique combined with very good close vision and accuracy. Very little is known about the feeding habits of Indian serpents.

MADRAS SNAKE PARK,
GUINDY DEER PARK,
MADRAS-22,
June 29, 1973.

R. WHITAKER

13. GEOGRAPHICAL VARIATION IN TOXICITY OF VENOM OF THE COBRA AND EXTRACTION BY VACUUM METHOD

Venom output studies are important to the Immunologist, the Clinician and the Biochemist. The first one requires more venom of sufficient toxicity for immunisation, the second one would like to know the quantity for neutralisation in treatment and third for experimentation. These records for some Indian snakes were completed for periodicity, differences in male and female and the output in farm and room (Deoras 1963, 1966). There are three varieties of Cobras showing different head markings. They are geographically separated. The monocellate is found in Bengal and Assam, and the Binocellate and Acellate in other parts of India. The differences in the toxicity of these three were not known. Secondly the vacuum method of extraction of venom had not been tried in India. This has been done for cobra, krait and Russel's Viper.

Material and Methods

In the routine method stainless steel funnel as used by Deoras (1963) was employed and the venom collected directly in the ampoule. This was deep-frozen and lyophilised and kept sealed under vacuum at –4°C. In the second method, a glass bottle was held by clamp. A thick plastic transparent sheet was firmly tied to the mouth by threads and elastic tape. A glass tubing with a thin point was inserted in one corner of the plastic cloth. The other end of the tubing was connected to a vacuum pump run on half horse power motor. Snake was made to bite the cloth and the vacuum started. Venom trickled in the bottle from the fangs.

The toxicity of the venom was worked out by I/V route in mice

Observations

Table No. 1 shows the maximum and minimum output of venom from the three mark-different varieties of cobra (*Naja naja*). The month at the base of the figures indicates the period of maximum and minimum output for each variety. The toxicity of the venom is highest in the monocellate cobra, though the maximum output is more in Acellate variety. Cobra is a powerful snake and after a bite it tries to move the fangs thus not only tearing the cloth but also nullyfying the vacuum. It is thus noted in Table No. 2 that there is no apparent

difference in the output of venom in cobra snakes by the vacuum method and otherwise. The snake also exhibited convulsive movements after the vacuum operations.

TABLE 1

DIFFERENTIAL OUTPUT OF VENOM IN GM FROM THREE HOOD MARK VARIETIES OF COBRAS

Season	Month	(*Naja naja*) Binocellate	(*Naja naja oxiana*) Acellate	(*Naja naja kaouthia*) Monocellate
	1969			
	July	0.1116	0.4553	0.1824
Rainy	August	0.1479	0.1194	0.0423
	September	0.1314	0.2894	0.1981
	October	0.1511	0.2963	0.1481
	November	0.1096	0.2663	0.1660
Winter	December	0.1029	0.2807	0.1337
	1970			
	January	0.0875	0.1144	0.2272
Summer	February	0.0863	0.1238	0.1611
	Average:	0.1160	0.2432	0.1573

TOXICITY:

Binocellate (*Naja naja*)	8.87
Monocellate (*Naja naja kaouthia*)	8.055
Acellate (*Naja naja oxiana*)	19.57

TABLE 2

DIFFERENTIAL OUTPUT OF VENOM IN GM IN COBRAS WITH MODIFIED MILKING METHODS

Month 1969	Without vacuum Male	Without vacuum Female	With vacuum Male	With vacuum Female
September	0.1518	0.1191	0.1438	0.1026
October	0.1838	0.0749	0.1356	0.0866
November	0.1552	0.0680	0.1097	0.0609
Average:	0.1636	0.0873	0.1297	0.0833

In the case of Krait (*Bungarus caeruleus*) the teeth being small and there being no further movements the vacuum method gave more amount of venom as shown in Table No. 3. The snake after the bite lifted the head releasing the grip as such it was easy to disentangle. There is no apparent difference in the toxicity of venom collected by the two methods as shown by Table 3.

TABLE 3

DIFFERENTIAL OUTPUT OF VENOM IN GM IN KRAITS WITH MODIFIED MILKING METHODS

Without vacuum 1968		With vacuum 1969		With vacuum 1970	
January	0.0097	April	0.0179	January	0.0115
February	0.0035	May	0.0236	February	0.0135
March	0.0047	June	0.0170	March	0.0172
April	0.0034	July	0.0210	April	0.0155
May	0.0148	August	0.0233	May	0.0231
November	0.0117	September	0.0207	June	0.0118
December	0.0064	October	0.0181	July	0.0139
1969					
January	0.0098	November	0.0178	August	0.0151
February	0.0076	December	0.0169	September	0.0167
March	0.0079			October	0.0141
				December	0.0133
Average	0.0080		0.0196		0.0150

DISCUSSION

Karlsson & Eaker (1971) have shown differences in the amino acid content of cobras collected from different geographical locations. Our findings give an answer to his observation. Cobra snakes having different markings are believed to be more toxic or otherwise. Our present findings show that the maximum output is given by the Acellate, but the toxicity is more in Monocellate cobras. These would help the clinicians to devise doses for curative purpose and the immunologist to incorporate all these three venoms as a pool to get good results in immunisation.

The vacuum method will now become a tool to collect more venom from Krait snakes, as this has been in short supply for some time.

ACKNOWLEDGEMENTS

We are extremely thankful to the Director, Haffkine Institute for all facilities during these investigations. University Grants Commission, New Delhi, covered a grant for the Senior author and the Principal, Patkar College, Bombay gave help from time to time; we are thankful to them.

HAFFKINE INSTITUTE,
BOMBAY-12,
July 25, 1973.

P. J. DEORAS
N. E. VAD

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14. ON *PSILOCEPHALUS BARBATUS* (GRAY), AN INTERESTING BALISTOID FISH TRAWLED OFF GANJAM COAST, ORISSA

(*With a text-figure*)

Recently Shri S. K. Mohanty, Superintendent of Fisheries, Biological Research Station, Balugaon, Orissa, sent the senior author a specimen of *Psilocephalus barbatus* (Gray), trawled on 25.i.73, at 15 fathoms depth off Rushikulya river mouth, Ganjam Coast, Orissa. A search of the Zoological Survey of India fish reserve collections reveals that the fish is represented by a single specimen collected by F. Day from Madras coast. Day's (1878 : 694) description and figure of the species were based on this specimen. Regarding the habitat of the fish he stated that the fish occurs in the "Seas of India to the Malaya Archipelago. Is very common at Madras, especially the young. It attains at least 10 inches in length." There is, however, no record of this fish from the Indian seas subsequent to that of Day and the present record of it from Orissa coast is, therefore, of special significance.

We know next to nothing of the biology of *Psilocephalus barbatus* eventhough it is found in shallow waters and the young according to Day (op. cit.) is in abundance along the Madras coast. The presence of a long fleshy barbel below the symphysis of the lower jaw strongly indicates that the fish is bottom dwelling, but it will be interesting to investigate, with its elongated snout and upturned mouth with small incisiform teeth in the jaws, how the fish makes a living. The gut content examined in the specimen available to us is found to mainly consist of a mush of Polychaete worms.

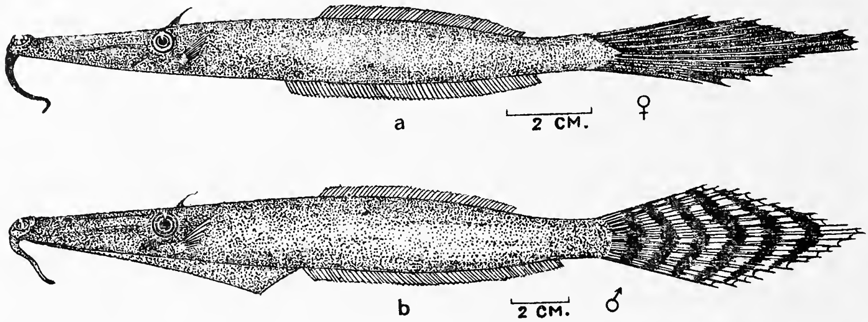
P. barbatus is the only representative of the family Psilocephalidae of the superfamily Balistoidea of the suborder Balistoidei. There are two suborders of the order Tetraodontiformes (Plectognathi) namely, Balistoidei (Sclerodermi) with three superfamilies (Triacanthoidea, Balistoidea and Ostraciontoidea), and Tetraodontoidei with four superfamilies (Triodontoidea, Tetraodontoidea, Diodontoidea and Moloidea). The superfamily Balistoidea composed of the filefishes, triggerfishes

and the leatherjackets, embraces four families namely, Balistidae, Monacanthidae, Aluteridae and Psilocephalidae.

A detailed description illustrated with a drawing made from the present specimen (Zoological Survey of India, Regd. No. F 68912; female) measuring 198 mm in T.L., is given below.

Psilocephalus barbatus (Gray)

1831. *Anacanthus barbatus* Gray, *Zool. Miscll.*, p. 8. (type loc: Singapore).
1865. *Psilocephalus barbatus* Bleeker, *Atlas Ichth.*, Vol. 5, pp. 5 & 143, pl. 226, fig. 1.
1878. *Anacanthus barbatus* Day, *Fish. India,* pt. 4, p. 694, pl. 179, fig. 1.
1889. *Anacanthus barbatus* Day, *Fauna Brit. India,* Fishes, Vol. 2, p. 483, fig. 173.
1955. *Anacanthus barbatus* Munro, *Mar. Freshw. Fish. Ceylon,* p. 276.
1962. *Anacanthus barbatus* Beaufort & Briggs, *Fish. Indo-Austr. Arch.*, Vol. 11, pp. 344, 345.



Psilocephalus barbatus (Gray). a. Female; b. Male after Bleeker 1865.
D.I + 53 A. 65 P. 8 C. 10

Body elongate and strongly compressed; depth 9.3 times, head 3.5 in standard length; snout elongated 1.2 times, diameter of eye 7.0 in head length. Mouth upturned, small and curved, incisiform teeth in two rows in upper jaw and one row in lower jaw. A fleshy barbel below the symphysis of the lower jaw, which is thick at the base and gradually tapering into a thread, 2.0 times in head length. Gill opening about as long as eye. Origin of pectorals slightly behind the posterior edge of the eye. The first dorsal fin in the form of a single flexible spine situated over the hind border of the eye, the length of the second dorsal fin base 3.0 times, and anal fin base 2.4 in standard length; pelvic absent; caudal fin wedge-shaped, it is longer than head, 2.5 times in standard length. Length of the caudal peduncle 7.3 times in standard length, its depth 2.5 times in its length. Distance between the anterior tip of snout and origin of first dorsal fin 3.8 times, that between the anterior tip of snout and origin of second dorsal fin 2.0 and

that between the anterior tip of snout and origin of anal fin 2.2 in standard length.

Colour in preserved specimen is uniformly dull brown on body with the caudal black, dorsal, anal and pectoral whitish. The six vertical dark caudal bands seen in the male (*vide* Bleeker's figure) are absent in our specimen and probably well marked only in the male.

A skinny prolongation on the throat extending as far as the anal base (*vide* Bleeker's figure) is a secondary sexual character of the male.

Distribution. From east coast of India through Indo-Australian archipelago to Philippines and to Queensland and West Australia.

ZOOLOGICAL SURVEY OF INDIA,
CALCUTTA,
June 20, 1973.

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T. K. CHATTERJEE

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15. ON THE OCCURRENCE AND BREEDING OF *LABEO ROHITA* (HAMILTON) IN A SECTION OF NARBADA RIVER IN GUJARAT STATE

Labeo rohita (Hamilton) is widely cultured all over India and is the most esteemed fish in Bengal and Orissa. The natural distribution of this fish, as recorded by Day (1878), is from Sind and the Punjab along upper India and Assam as far as Burma, though it is now known to occur in Peninsular India in the Hirakud stretch of the Mahanadi Job *et al.* 1955), the Godavari river system (Alikunhi & Chaudhuri 1951) and the lower reaches of Godavari and Krishna rivers (David 1963). Of the two important westerly flowing rivers of Peninsular India, this fish is not known to occur in Narbada (Anon. 1956; Hora & Nair 1941; and Rajan & Kaushik 1958), though recently this fish has been recorded from Tapti, where it was accidently transplanted (Karamchandani & Pisolkar 1967). The nonavailability of this species in Narbada was also indicated by the enquiries made from fishermen during fishery survey of 1958-59 and the observations on the capture fishery of the entire stretch of the river in Madhya Pradesh and Gujarat State (1958-1966).

While exploring new fish seed resources in the lower stretches of

Narbada river in Gujarat State during south-west monsoon season of the years 1959 to 1964, the occurrence and breeding of Rohu were observed in a section of Narbada river during 1960 monsoon season. The evidence thereof are reported in the present note.

The representative samples of carp spawn collected at Malsar, Poicha and Mangrol centres from Narbada river from 30.vi.1960 to 29.ix.1960 were reared in the field laboratory and the local nursery tanks, with a view to ascertaining the quality of Narbada seed. The percentage composition of rohu, catla, mrigal and the minor carps in the Narbada seed collected at various centres was found to be as follows:—

	Percentage composition of			
Centres	Rohu	Catla	Mrigal	Minor carps
Mangrol	4.97	67.7	11.18	16.15
Malsar	4.0	65.0	25.0	6.0
Poicha	—	12.1	66.3	21.6

Since the seasonal tanks at these centres were stocked exclusively with Narbada fish seed, these observations have conclusively indicated that Rohu not only occurs in Narbada river but also breeds successfully during monsoon season in the lower reaches of this river above Mangrol. These observations are particularly significant in view of the belief that rohu does not occur in Narbada (Anon. 1956).

The occurrence of rohu in Narbada river, as reported above, appears to be the result of accidental stocking. Recently, Karamchandani & Pisolkar (1967) reported accidental transplantation of catla and rohu into Tapti river from Vyara tank through Mindhola river. The culture of major carps namely catla, rohu, mrigal and kalbasu in large tanks all over the country, by transplanting their seed from natural habitats, is an age old practice. The occurrence of rohu in some of the major rivers of Peninsular India (Job *et al.* 1955; Alikunhi & Chaudhuri 1951; David 1963, and Karamchandani & Pisolkar 1967), well outside the range of its natural distribution (Day 1878), seems to point out that the involuntary and accidental transplantation of major carps from over-flooded stocking tanks during monsoon floods directly into the rivers or through their tributaries is a common feature and perhaps has been mainly responsible for their subsequent wide distribution in the country. In the present case, the overflowing of stocked tanks during monsoon seasons must be the reason for the presence of rohu in Narbada river.

Karamchandani *et al.* (1967) have observed that the percentage of major carps in the commercial catches of Narbada river is extremely poor. The occurrence and the breeding of rohu in Narbada river have

conclusively indicated that this fish is capable of thriving in Narbada river. Extensive stocking of rohu and other major carp species in Narbada river appears to be desirable with a view to augment their fisheries as well as enrich the resources of the quality fish seed of this river.

ACKNOWLEDGEMENTS

We are grateful to Dr. V. G. Jhingran, Director for his interest in this work and to Shri J. C. Malhotra, Fishery Scientist, for going through the manuscript. Their grateful thanks are due to the Director, Zoological Survey of India, Calcutta, for confirming the identification.

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March 30, 1974.

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16. NEW RECORDS OF OFFSHORE FISHES FROM THE WEST COAST OF INDIA

While collecting marine animals in March, 1971 from otter trawl hauls made over a rocky bottomed continental slope off Quilon coast (Kerala) at depths ranging from 135-150 fathoms, the following species were obtained. The sharks, *Scyliorhinus* (*Halaelurus*) *natalensis* (Regan) 1904 known from the coast of Natal and *Proscyllium alcocki* Misra, 1950 fro mthe Andaman Sea. A ray *Narcine mollis* Lloyd 1907 known from Gulf of Aden and now reported for the first time from the west coast of India. In addition, a brotulid, *Neobythites squamipinnis* (Alcock) 1889 known from Bay of Bengal and Zanzibar, a triglid, *Trigla hemisticta* Schlegel 1842 from Muscat, off Madras and Japan and a triacanthodid, *Mephisto fraserbrunneri* Tyler 1966 from Andaman Sea and off Somalia are also new records for the west coast of India.

MARINE BIOLOGICAL STATION, K. V. RAMA RAO
ZOOLOGICAL SURVEY OF INDIA,
10, LEITH CASTLE SOUTH STREET,
MADRAS-28,
July 25, 1973.

17. A NEW SPECIES OF *PUNTIUS* (CYPRINIFORMES : CYPRINIDAE) FROM KHASI & JAINTIA HILLS (MEGHALAYA), INDIA

(*With a text-figure*)

The fish described here has often been confused with *Puntius ticto* (Ham.) (Day 1889; Misra 1862), for both appear alike due to their small size and presence of spot on the tail. However, a detailed examination of this fish undertaken recently has revealed the fact that it represents a new species closely related to *Puntius ticto*.

Puntius shalynius sp. nov.

Diagnosis:

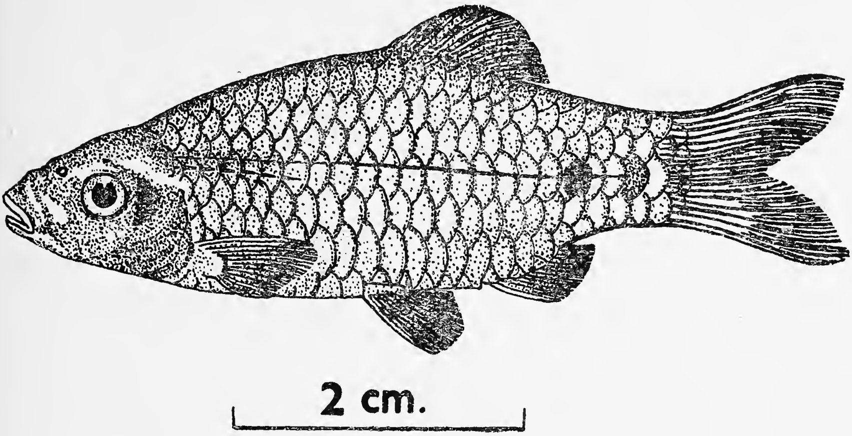
Carp-minnow without barbels, having the last undivided dorsal ray serrated; 6-7 scales in the transverse and 20-23 scales in the longitudinal row; lateral line incomplete, ending on or before 11th scale; two black spots on tail and a horizontal blue line on the body.

Description:

B. 3; D. 3/7; P. 13-14; V. 1/7; A. 2/5; C. 18-20

Greatest depth of body 28.6 to 37.8, length of head 26.0 to 34.10,

length of caudal peduncle 18.6 to 23.00, depth of caudal peduncle 12.25 to 17.35, longest ray of dorsal 21.60 to 29.10, length of caudal 26.00 to 37.20; all in standard length. Height of head 73.30 to 84.60, length of snout 25.00 to 30.80, post-orbital head length 40.00 to 46.20, interorbital head length 30.40 to 46.20, eye-diameter 25.00 to 33.30, all in head length.



Puntius shalynius sp. nov.

Dorsal profile a little more convex than the ventral profile; origin of dorsal nearer the base of caudal than the tip of snout; three undivided dorsal rays, the first almost indistinct and the third longest with serration on its posterior face; barbels absent; scale sfairly big, hexagonal with anterior margins distinctly wavy; lateral line incomplete, ceasing on or before 11th scale and variable between two sides in the same individual; 20 to 30 scales in the longitudinal and 6 to 7 scales in the transverse rows; 3 to 4 scales between base of dorsal and lateral line and $2\frac{1}{2}$ to $3\frac{1}{2}$ scales between lateral line and base of ventral; 9 to 10 scales before dorsal. In some males, minute white tubercles present on head.

Colour variable (in spirit) : Females yellow to black on sides and back, silvery below; scales black-edged; fins mostly orange with light blackish tinge; Males more blackish in appearance, fins except caudal jet black. Two spots on either side of the tail in both sexes, the anterior one (situated nearly opposite the end of the anal) more distinct than the posterior (situated near the base of caudal); a blue horizontal line along the middle or body and minute black spots on sides of head.

Type-specimens:

The type-specimens are deposited in the National Collection, Zoological Survey of India, Calcutta.

Holotype: Male, total length 58.0 mm from Barapani lake,

c. 20 km north of Shillong, Khasi Hills, Meghalaya, Coll. S. K. Talukdar, February 11, 1972, altitude 1,100 metres. Reg. No. V/ERS 511, Zoological Survey of India.

Paratypes: Nine specimens, total lengths 28.5 to 60.0 mm; out of which one (Allotype), total length 53.5 mm, with same data as that of holotype and two from Mawpat *c* 7 km NE of Shillong, coll. G. M. Yazdani, September 3, 1970; three from Mylliem *c* 25 km SW of Shillong, coll. S. K. Chanda, March 18, 1971; three from a tank at Jowai, Jaintia Hills, Meghalaya, coll. K. Reddiah, December 18, 1960. Reg. No. V/ERS 512-515, Zoological Survey of India.

Relationship:

Puntius shalynius belongs to that group of *Puntius* spp. which lack barbels and possess serration on the last undivided dorsal ray. It, however, differs from all the species of this group by having 7 (*vs* 8) branched rays in the dorsal and can be distinguished further from its close ally, *Puntius ticto*, by 6-7 (*vs* 12) scales in the transverse row, a horizontal blue line on the body and two spots on the tail.

Remarks:

Puntius shalynius, the specific name of which is derived from local (Khasi & Jaintia) name '*shalyni*', occurs in most streams, lake and pools in the Khasi & Jaintia hills. Sehegal (1959) reported *Puntius ticto* from Shillong, Jowai and Jaintiapur in these hills. Although we have examined a large collection of *Puntius* spp. from the eastern Indian region, we have not come across *P. ticto* in the Khasi and Jaintia Hills. We, therefore, feel that Sehegal's records of *P. ticto* from Shillong, Jowai and Jaintiapur are due to erroneous identification. This fish is eaten by the local people and is of some commercial value.

Acknowledgements

We are grateful to Dr. A. P. Kapur, former Director, Zoological Survey of India, Calcutta, for providing the opportunity and to Dr. R. S. Pillai, Superintending Zoologist of this Station for encouragement and advice.

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July 15, 1974.

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18. ON TWO SPECIES OF TICKS (IXODOIDEA: IXODIDAE) ON A TIGER FROM ARUNACHAL PRADESH

During a recent faunistic survey in the Siang district, Arunachal Pradesh twelve tick specimens were collected from the body of a tiger which had been killed by tribals in the forested mountain of Kaying, 20 Km north of Along. The tick specimens belong to two difffferent species and are reported here.

1. **Haemaphysalis (Kaiseriana) davisi** Hoogstraal, Dhanda & Bhat.

5 ♂♂, Arunachal Pradesh: Kaying (Alt. 400 metres), Siang district, 10.ii.1973 from Tiger, *Panthera tigris.*

The species has been described in detail only recently (Hoogstraal *et al.* 1970) from collections made in Burma, Sikkim and Arunachal Pradesh. Recorded hosts of adults from Arunachal are gaur, cattle, goat and mules but elsewhere hosts include tiger, hog badger and barking deer. The present specimens collected at Kaying show exceptionally developed postero-external juncture of palpal segment 2. The available records show its occurrence in tropical and temperate zones between 145 - 2700 metre altitude.

2. **Ixodes (Partipalpiger) ovatus** Neumann.

3 ♂♂ and 4 ♀♀, Arunachal Pradesh: Kaying, Siang district, 10.ii.1973 from Tiger, (*Panthera tigris*).

Another asiatic species, which is distributed according to Hoogstraal *et al.* (1973) in Burma, China (Tibet), Japan, India (Jammu; Kameng district, Arunachal Pradesh), Nepal, Taiwan and Thailand. Recorded hosts include birds (Pheasant), wild dog, jackal, deer, goral, serow, domestic dog and cattle. Tiger is thus a new host for this species and its record from Kaying extends its distribution within Arunachal. It may be added that members of the genus *Ixodes* are normally highly specialized in their habits and frequently parasitize seldom-examined hosts which may explain lack of any previous record of *Ixodes* from Tiger. Hoogstraal *et al.* (op. cit.) have recently erected a new subgenus *Partipalpiger* for accommodating *I. ovatus* which shows a number of unique and unusual features in both adult and immature stages and shares characters of *Ixodes* s. str., *Afrixodes* and *Exopalpiger.*

Acknowledgement

I thank Dr. Harry Hoogstraal, Head of the Medical Zoology Department, United States Naval Medical Research Unit No. 3, Egypt for his valuable help in the determination of tick specimens and Dr. R. S. Pillai, Officer-in-Charge, E.R.S., Z.S.I. for working facilities.

Eastern Regional Station, A. K. GHOSH
Zoological Survey of India,
Shillong,
November 16, 1973.

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19. PREFERENTIAL FEEDING IN CAPTIVITY BY A FRESH WATER CRAB, *POTAMON ATKINSONIANUM* WOOD-MASON (CRUSTACEA: POTAMONIDAE) ON *NOTONECTA UNDULATA* (INSECTA: HEMIPTERA)

Potamon atkinsonianum Wood-Mason was recently collected and identified by me from the fresh waters of the Poonch valley. The abundance of this crab varied in different localities of the valley in association with microcrustaceans, aquatic insects and small fishes. This note is an account of the selective feeding by this crab on the aquatic insect *Notonecta undulata.*

Five specimens of the crab were captured between 12-15th November 1970 with specially designed nets of *c.*22 cm diameter and one metre scoop. They were brought alive to the laboratory for observation. Of the five, two were male and 3 were female. One male was kept in an aquarium, to study its preferential feeding on some aquatic insects collected from the same habitat. Various aquatic insects which were collected from the same locality as the crab were given as meals to the crab. The insects included *Gerris* sp., *Nepa* sp., *Dysticus marginalis, Notonecta undulata* and *Hydrophilus* sp.

In addition, nymphs and larvae of chironomids, mayflies and Odonata were also used. Among this variety of possible food the crab

favoured *Notonecta undulata* as food. The table givees the data of the experimental feeding of the crab.

TABLE

Date	Species of Insect	Number of insects given	Number of insects taken
16.xi.1970	*Nepa* sp.	16	1
17.xi.1970	*Notonecta undulata*	7	7
18.xi.1970	*Gerris* sp.	10	2
19.xi.1970	*Hydrophilus* sp.	5	1
20.xi.1970	*Notonecta undulata*	15	15
21.xi.1970	Chironomids	10	8
22.xi.1970	Mayflies (Larvae)	6	2
23.xi.1970	Odonata (Larvae)	14	3

In the available literature on the Potamonidae of India, there is no specific reference to the occurrence of the crab *Potamon atkinsonianum* Wood-Mason in the Poonch Valley. This note is therefore, a first record of the crab from the Poonch Valley.

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POONCH, (JAMMU & KASHMIR),
July 3, 1971.

B. D. SHARMA

20. RECORD OF NEW HOST-PLANTS OF FOUR AGROMYZIDS

The Agromyzids, destructive in larval stages, not only devour the pallisade and spongy mesenchymatous tissues and largely avoid the endodermal cells containing starch (Trehan & Sehgal 1963), but also render the seeds unfit for human consumption and sowing purposes. The mines caused by the larvae are irregular linear and distinct but, in certain cases, they anastomose. The following four Agromyzids have been collected from the host plants shown under each.

1. **Liriomyza brassicae** Ril.

Spencer (1961) has reported this species from New Delhi, Singapore, Manila (Philippines), and Colombo (Ceylon), from leaf mines on cauliflower; *Cleome graveolens* Rafin; and *Gynandropsis speciosa* D.C. Sehgal & Trehan (1963) have bred *L. brassicae* from the leaf mines on *Brassica campestris* L. and *Trapaeolum majus* L. at Chandigarh and Ferozepur (Punjab), and Ranchi (Bihar). The following five host plants at Damoh, Madhya Pradesh, form new records of hosts.

Species of host plant	Date of collection
Brassica juncea Czerm & Coss (Cruciferae)	17.ii.1966
Dahlia variabilis Desf. (Compositae)	19.iii.1965
Reseda odorata L. (Resedaceae)	18.ii.1966
Trapaeolum minus L. (Trapaeolaeae)	7.ii.1966
Verbena phlogiflora Cham. (Verbenaceae)	26.iv.1966

2. **Melanagromyza theae** Green

This Agromyzid is active during the rainy season though the damage is not noticed till November. *M. theae* has been bred from the mines on the leaves of the following host plants:

Species of host plant	Date of collection
Argyreia sericea Dalz. & Gibs. (Convolvulaceae)	18.ix.1965
Clitoria pilosula Wall. (Papilionaceae)	17.ix.1965
Gossypium hirsutum Linn. (Malvaceae)	28.ix.1966
Sida acuta Burm. (Malvaceae)	7.x.1965

G. hirsutum has been collected from village Berdi (Distt. Chhindwara), Madhya Pradesh, and the three other hosts have been collected from Damoh, Madhya Pradesh.

3. **Ophiomyia (=Melanagromyza) beckeri** Hd.

Sehgal & Trehan (1963) had bred *M. beckeri* for the first time from the Oriental region from the host plant *Launea nudicaulis* (Compositae). This species has now been noted on the following host plants at Damoh, Madhya Pradesh.

Species of host plant	Date of collection
Launea asplenifolia D.C. (Compositae)	1.iii.1965
Sonchus arvensis Linn. (Compositae)	16.v.1966

4. **Pseudonapomyza asiatica** Spencer

Spencer (1961) has recorded *P. asiatica* from Singapore, Bombay and Hyderabad from the leaf mines on *Cynodon dactylon* Pers., *Eragrostis* sp. and rice. Sehgal & Trehan (1963) bred this species from leaf mines on *C. dactylon* Pers. *Oryza sativa* L. and *Eragrostis nigra* Nees. The species has been now bred from the leaf mines on the following host plants at Damoh, Madhya Pradesh.

Species of host plant	Date of collection
Eragrostis pilosa Beauv. (Graminae)	10.viii.1966
Zea mays L. (Graminae)	9.viii.1966

ACKNOWLEDGEMENT

I am thankful to Mr. S. C. Sen Gupta, Director and Dr. A. Bhattacharya, Entomologist, for providing the facilities to work; to Mr. B. P. Mehra, Scientific Officer, for scrutinising the manuscript; to Mr. K. A. Spencer, London, for identifying the agromyzids; and to Mr. S. Kedharnath and Mr. H. B. Naithani, Forest Research Institute, Dehra Dun, for identifying the host plants.

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NAMKUM, RANCHI, BIHAR,
September 17, 1971.

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21. NEW ALTERNATE HOST RECORD OF LEAF ROLLER, *MARASMIA TRAPEZALIS* GN. (LEPIDOPTERA : PYRALIDAE)

The leaf roller, *Marasmia trapezalis* Gn. has been recorded on maize, Jowar, bajra, ragi, and cane as a minor pest. During the course of field observations, *Marasmia trapezalis* was noticed on Para grass (*Brachiaria mutica* Raddi). To record its incidence, 60 plants growing on bunds, were observed for counting the number of caterpillars and damaged leaves. The larva lives in a folded leaf and strips the upper surface so that the leaf turns white and dries. The average number of caterpillars and damaged leaves per plant was found to be 1 and 3 respectively.

The para grass *Brachiaria mutica*, is a new alternate host of *Marasmia trapezalis*. In combating the pest on main crop it is suggested that bunds should be kept clean to reduce their multiplication.

J. N. K. VISHVA VIDYALAYA, R. K. PATEL
JABALPUR, M.P., B. S. CHOUDHARY
March 30, 1972. A. K. KHATRI

22. FURTHER COLLECTION OF THE SYRPHIDAE (DIPTERA) FROM CENTRAL INDIA

R. S. Gokulpure's note under the above heading in this *Journal*, Vol. *68*(3):848 states that the Syrphidae play an important part in checking aphids. This remark, without qualification, may give rise to misunderstanding as many Syrphids do not feed on aphids in the larval stages.

I quote from Imm's TEXTBOOK OF ENTOMOLOGY as under:— The larval habits of Syrphidae are extremely varied. They may be:— (a) *Phytophagous*, feeding externally upon plants (*Mesogramma polita*) or internally in bulbs (*Merodon equestris, Eumerus strigatus*) or within stems or in fungi (*Chilosia*). (b) *Carnivorous*, living predaceously upon aphids and the nymphs of other Homoptera (species of *Pipiza, Paragus, Melanostoma, Baccha, Syrphus*, etc.). (c) *Saprophagous*, living in decaying organic material, dung, liquid mud or dirty water (species of *Eristalis, Helophilus, Platychirus, Sericomyia, Syritta, Tropidia*, etc.): in the sap and wet rotting wood of diseased parts of trees (*Xylota, Mallota, Myriatropa, Myiolepta, Ceria*, etc.): or as scavengers in the nests of ants and termites (*Microdon*) or of Aculeate Hymenoptera (*Volucella*).

From the above it will be seen that not all Syrphids are the gardener's friends.

P.O. Box 95206, D. G. SEVASTOPULO
MOMBASA,
April 16, 1972.

23. ON A NEW SUBSPECIES OF *AETHUS LATICOLLIS* WAGNER (HEMIPTERA : HETEROPTERA : CYDNIDAE) AS A SERIOUS PEST OF *PENNISETUM TYPHOIDES* (BURM.) IN INDIA

(*With two text-figures*)

A small collection of burrower bugs of the genus *Aethus* have been submitted for identification by Dr. Gurdev Singh Sandhu, Entomologist (Maize), Punjab Agricultural University, Ludhiana, India, with a short note reporting their appearance as serious pest of *Pennisetum typhoides* (Burm.), commonly known as *Bajra* or *Bajri*, a millet crop traditionally cultivated as *Barani* crop in semi-arid areas around Delhi, Rajasthan, Haryana and South East Punjab. Dr. Sandhu also informs that this new pest is now shifting to Wheat in sandy areas of Punjab.

Examination of the specimens revealed that they belong to a new

subspecies of *Aethus laticollis* Wagner (1954, pp. 1-3). Hitherto, this species has been known from Canary Is., Southern Europe, North Africa and adjoining areas, more or less between latitude 30-35 North. The present finding of a new subspecies between the same latitudes but a little eastward is not surprising. As far as it is known *Aethus laticollis* or its allies have never been reported as pest of economic crops from any area of their distribution, prior to Dr. Sandhu's report. The appearence of the new subspecies as a serious pest is therefore unusual. The reason for a sudden increase in its population could be attributed to the ecological changes being brought about as a result of artificial irrigation in and around traditionally semi-arid districts of Ludhiana, Ferozepur etc. A parallel case occurred in the districts of Lower Baluchistan and Upper Sind, Pakistan, in the early thirties of this century (Ahmad & Ghauri 1953).

There the scanty annual rainfall maintained a limited, nevertheless a fluctuating population in direct proportion to the amount of moisture available, of two species of Gryllids, *Acheta domestica* (Linneaus) and *Acheta hispanica* (Rambur). With the advent of canal irrigation, vast areas began to receive regular moisture. The new irrigation facilities were planned to be utilised for extensive cotton growing by the then British Cotton Growing Association, in India. The supply of moisture coupled with the cotton seeds and seedlings serving the crickets as food gave such a boost to their population that within a short period their small and scattered pockets rose steeply in numbers and assumed out-break proportions. The damage inflicted to the newly introduced Cotton crop was so serious that after a few futile attempts to control the pests, the B.C.G.A. had to abandon their project in these areas.

Aethus Dallas

Dallas, 1851, pp. 110 & 112. Type species, *Cydnus indicus* Westwood, 1837, p. 19.

Aethus laticollis Wagner subspecies **orientalis** ssp. n.

Colour.

Dark brown to chestnut brown, more or less similar to that of nominate species.

Size.

Total length of body 3.75-4.00 mm, maximum width at about middle of body 2.50-2.75 mm.

Structure.

Ocelli prominent, space between them slightly more than $1\frac{1}{2}$ times width of an eye (4.00 : 2.85); width of vertex between eyes $2\frac{1}{4}$ times width of an eye (6.45 : 2.85), total width of head across eyes 4 times width of an eye (11.33 : 2.85); eyes prominent. Paramere (clasper)

with subapical lobe very prominent, apex slightly conical, setose margin appreciably concave, marginal denticulation very clear, dorsoventral setae extending upto middle of paramere; aedeagus and theca similar to that of *Aethus l. laticollis* Wagner.

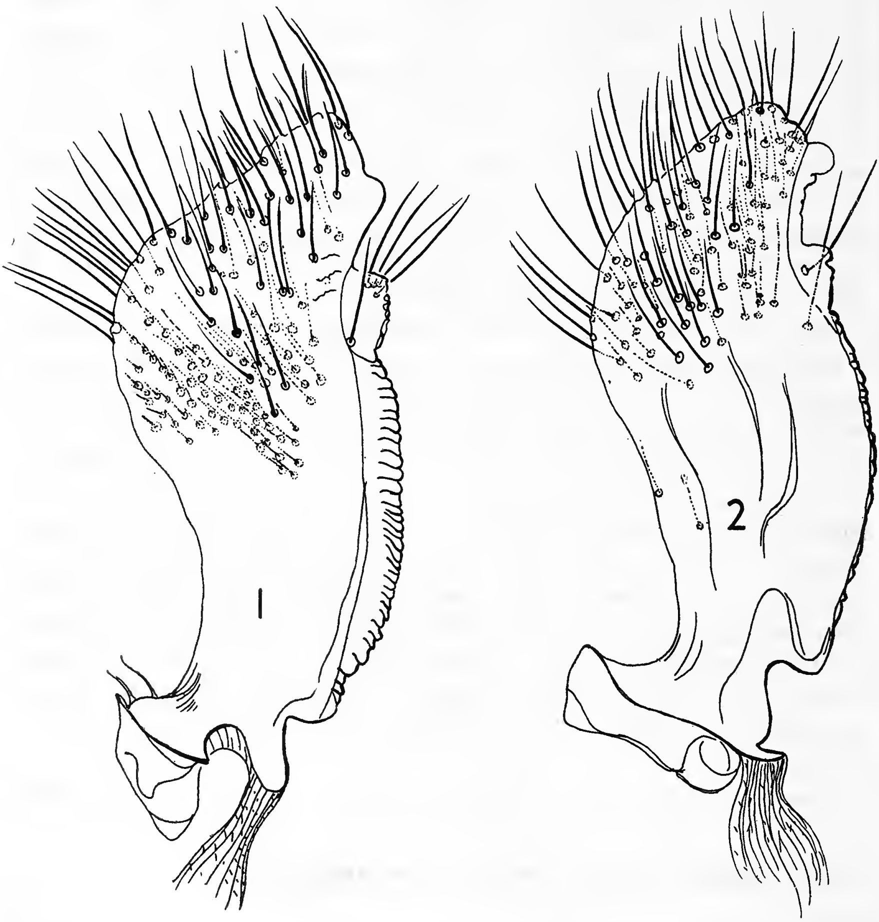

Fig. 1. Left paramere of *Aethus laticollis* ssp. n. Fig. 2. Left paramere of *Aethus l. laticollis* Wagner, based on the ♂ paratype in the British Museum (Natural History), London.

Comments.

The new subspecies differs from its nominate form mainly in its prominent ocelli and eyes, narrower vertex and the apex, the subapical lobe and more numerous setae of paramere (compare fig. 1 and 2).

HOLOTYPE ♂, Ludhiana, ix. 1971 (*Punjab Agricultural University, Ludhiana*); paratypes 2 ♂♂ and 1 ♀, same data as holotype; deposited in the British Museum (Natural History), London.

Vidal (1949) and Stichel (1961) illustrated and described *Aethus*

laticollis Wagner under the name of *Aethus pilosulus* Klug (*vide* Wagner 1954, pp. 2-3).

ACKNOWLEDGEMENTS

I take this opportunity to express my thanks to Dr. P. Freeman, Keeper, Department of Entomology, British Museum (Natural History), London, for facilities provided. Thanks are also due to Dr. G. S. Sandhu who supplied the material.

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LONDON, S.W.7,
February 17, 1972.

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24. *DATURA SUAVEOLENS* H.B. EX WILLD. (SOLANACEAE)—FROM DISTRICT CHAMOLI IN WESTERN HIMALAYAS

Datura suaveolens H.B. ex. Willd. Enum. Hort. Berol. 227.
An indigenous species of Mexico introduced in India as an ornamental plant. Raizada (1931) recorded it, growing in shady places in perfectly naturalized conditions, from Dehradun of upper Gangetic plain. In 1936 Raizada further gave its account.

During a floristic field study of Karanprayag block in Chamoli district I collected this species, from village Jakh, Tallachandpur, near Manda Khali on 24.vi.72. *Nautiyal* 5502, 145 m; wild in dry exposed habitat.

The taxon is distinguished by its shrubby habit and large, pendulous, white, sweet scented, flowers.

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MEERUT,
June 18, 1973.

REFERENCES

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25. A NOTE ON THE DISTRIBUTION OF *SPERGULARIA RUBRA* (LINN.) J. & C. PRESL. (CARYOPHYLLACEAE)

Spergularia rubra (Linn.) J. & C. Presl. is a caryphyllaceous common arable weed of cultivated fields. It is widely distributed in North and West Asia and throughout Europe. Although it is reported from the plains of Punjab and adjacent areas, this is the first report of its occurrence in Delhi.

The correct nomenclature, and ecological notes of this taxon are given here.

Spergularia rubra (Linn.) J. & C. Presl. Fl. Cechica 94. 1819.–*Arenaria rubra* Linn. Sp. Pl. 423. 1753—*Spergula rubra* (Linn.) Dietr. Sym. Pl. 2: 1598. 1840; Edgew. & Hook. f. in Fl. Brit. Ind. 1 :144. 1874; Duthie Fl. Upp. Gang. Pl. 1. 64. 1960 (repr. ed.).

Spergularia rubra is infrequent on old alluvial soils and is absent on recent alluvial, low lying alluvial and residual soils of Delhi.

Specimens examined; Delhi : Alipur, Bhat WW 382 (Herb. of S.S. College). Flowers and fruits: February-April.

DEPT. OF BOTANY,
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July 21, 1973.

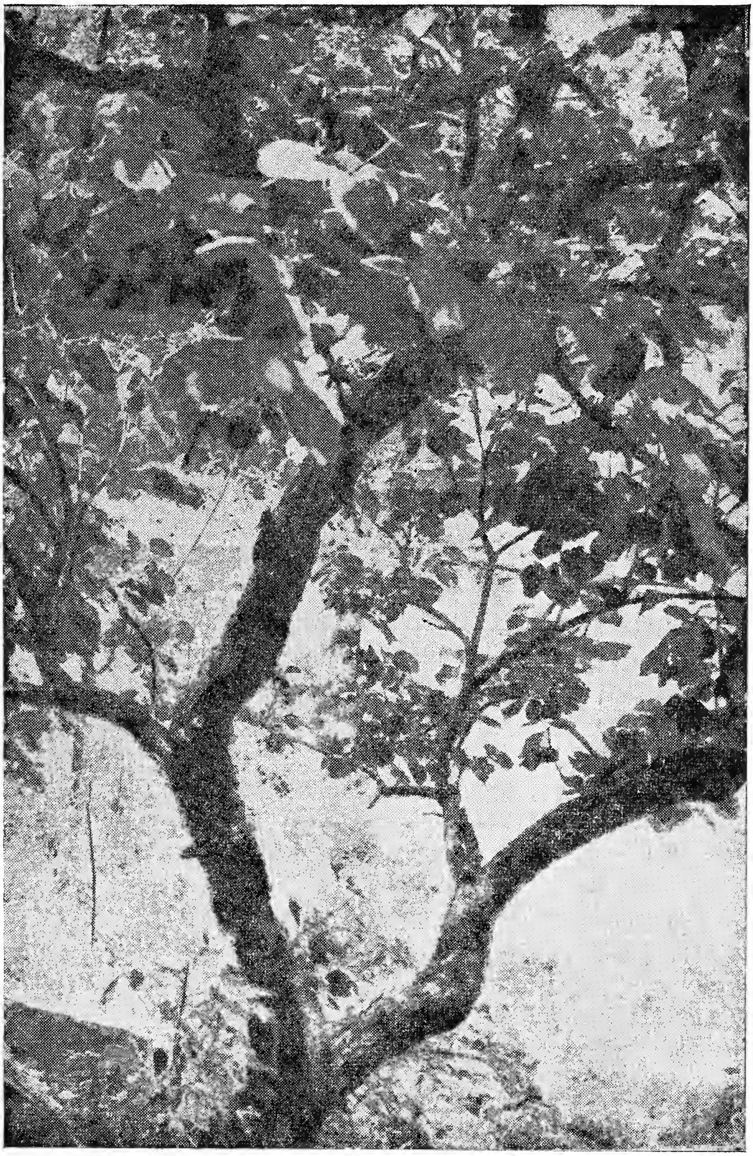
J. L. BHAT
S. KUMAR

26. NOTES ON SOME INTERESTING PLANTS FROM SOUTH INDIA—III

(*With a photograph*)

Cissus vitiginea Linn. Sp. Pl. 117. 1753; Planchon in DC. Monogr. Phan. 5(2): 472. 1883; Gamble, Fl. Pres. Madras 2: 234. 1918. *Vitis linnaei* Wall. ex Wt. & Arn. 1: 126. 1834; Lawson in Hook. f. Fl. Brit. India 1: 649. 1874; Cooke, Fl. Pres. Bombay 1:268. 1958 (rep. ed.). *V. vitiginea* (Linn.) Haines, Bot. Bihar & Orissa 2: 201. 1921.

Since Linnaeus' publication the climbing habit of the plant has been emphasized by all workers, including Planchon (1883) who has done a monographic study of the taxon on a world basis. Apparently the additional arboreal habit of this plant seems to have escaped notice.



Cissus vitiginea Linn.
(Bairani, Diguvametta, Nallamalais, Andhra Pradesh, 7-8-1972, *Ellis MH* 42193)

Gamble (1918) who had considerable field experience appears to be the only one to have indicated rather hesitantly about its arboreal habit. This hesistancy had stemmed from his collection from Nigadi Hills (800 m) in Cuddapah District, Andhra Pradesh, S. India, the herbarium specimen of which is represented in MH on which he has made the following annotation: "Sm. Tree—erect, 6 in. diam."

The present collections from Nallamalais have definitely indicated its arboreal habit also (Photo). The trees are rather stunted and dichotomously branched, reaching a height of 4-5 m and having a trunk of about 60 cm diameter. The bark of the trunk is suberous and fissured. The search for the tendrils, if any, proved futile. These trees are commonly found in Nallamalais, Eastern Ghats, South India.

Exsicc.: ANDHRA PRADESH: Nigadi Hills, Cuddapah Dt., July 1884, *J.S. Gamble* 15210; Chelama, Nallamalais, 5-7-1963, *Ellis MH* 16769; Pathalaganga-Srisailam, Nallamalais, Andhra Pradesh, 20-10-1964, *Ellis MH* 22107; Bairani, Diguvametta, Nallamalais, Andhra Pradesh, 7-8-1972, *Ellis MH* 42193.

Parinari indicum (Bedd.) Bedd. Ic. Pl. Ind. Or. p. 22-23, t. 109. 1874; Hook. f. Fl. Brit. Ind. 2: 311. 1878; Gamble, Fl. Pres. Madras 3: 437. 1919. *Entosiphon indicus* Bedd. in Madras Journ. Sci. ser. 3. 1: 45. 1864.

This member of the chrysobalanaceae has been collected on the western slopes at low elevations near Pandiar dam site, Nadugani, Nilgiris, during a seasonal visit to the western portion of the Nilgiris.

Beddome's description of the plant in 1864 is from a collection of the plant from the Carcoor Ghat in Wynaad. Since the first collection, apparently it has not been collected subsequently, indicating thereby that the plant is rare and endemic to the western slopes of the Nilgiris. The plant, however, is rather conspicuous amidst the evergreen forest with its prominent bracteate inflorescence and white flowers. It attains a height of 15 m, having a girth of 25 cm. The bark is greyish with large white patches.

Excisc: 'Wynaad, *Entisiphon indicus*' (Beddome?) (Date not given) Ac. *MH* 19328; Carcoor Ghat, Wynaad, '*Parinarium indicum* Bedd. (Entosiphon)', (Beddome?) (Date not given), Ac. *MH* 19330 (TYPE?); Devala, 3000 ft., 10-2-1890, *M. A. Lawson* s.n., Ac. *MH* 19329; Nadugani, Nilgiris, 500 m, 18-10-1972, *Ellis MH* 43246.

Polypogon fugax Nees ex Steud. Syn. Pl. Gl. 1: 184. 1854; Bor in Kanjilal's Fl. Assam 5: 155. 1940; Mitra, Fl. Pl. East. India, Monocot. 1: 171. 1958; Bor, Grasses of Burma, Ceylon, India and Pakistan 403. 1960. *P. higagaweri* Steud. Syn. Pl. Gl. 1: 422. 1855. *P. littoralis* Sm. var. *higagaweri* Hook. f. Fl. Brit. India 7: 246. 1896; Prain, Beng. Pl. 2: 913. 1963 (rep. ed.); Mitra, Fl. Pl. East. Ind. Monocot.

1: 171. 1958. *P. monspeliensis sensu* Hook. f. l.c. 7: 245-246. 1896, *p.p.*

This grass has been collected from the western slopes of the Nilgiris, south India, at an altitude of 2000 m. It has been hitherto reported only from the eastern Himalayas. In addition to its being a new record for peninsular India, its apparent preference for orophytic habitats deserves special attention.

The plant's taxonomic position seems to have had a tortuous course, for several workers have accorded it different treatment, including Hooker. f. (1896), Prain (1903), Haines (1924), and Mitra (1958). Bor (1940 and 1960) with his vast knowledge of the tropical grasses, however, has settled the problem by treating it as a species distinct from *P. monspeliensis* (Linn.) Desf. He differentiates the two species thus:

1. Awns 5-9.75 mm long, 2-3 times the length of the glumes.......... *P. monspeliensis*

1. Awns 1.25-3.75 mm long, as long as or shorter than the glumes...... *P. fugax*

Exsicc.: ASSAM: Manipur Road, Naga Hills, 30-8-1937, *N. L. Bor* 15458; On way to Sadiya, Assam, 1950, *K.W.* (?) 19506; *K.W.* 20089; No locality, no date, nor collector given, Fl. Nos. 2801 and 4461. SOUTH INDIA: along the streams—Porthimund, Nilgiris, 27-10-1972, *Ellis MH* 43422.

Strobilanthrs spp. (*sensu lato*) in the Nilgiris.

The periodicity in the gregarious flowering of the members of the genus *Strobilanthes* Bl. (*sensu lato*) has attracted both the botanist and the common man, the former for the scientific reasons and the latter for aesthetic and economic reasons. The recent gregarious flowering of *Phlebophyllum kunthianum* Nees in 1970 in peninsular India attracted a lot of attention. Time and again Nees (1832), Wight (1850), T. Anderson (1864), C. B. Clarke (1885), Cooke (1904), Fyson (1915, 1932), Gamble (1925), Bremekamp (1944), Santapau (1951), among others, have recorded the periodicity of gregarious flowering of this taxon. Press reports have also come in periodically. The periodicity of flowering, however, has to be taken with caution in case one judges only from the herbarium specimens; the collections may be of sporadic flowering. However, the following data collected from the herbarium sheets kept in MH, in addition to the recent collections, should indicate with a fair amount of accuracy the periodicity and gregarious flowering in the Nilgiris. This gains all the more importance because of the position of the Nilgiris which happens to be in the meeting ground of the two great hill ranges of peninsular India, namely Western Ghats and Eastern Ghats ranging in altitude from 500 m to 2000 m, and a rainfall from 20 cm to 400 cm.

It is interesting to note that some species which had been collected earlier from the Nilgiris have not been collected since, suggesting the possibility of their having become extinct from the Nilgiris; these taxa have been indicated with asterisks. Gamble has recorded by name 22 taxa as occurring in the Nilgiris, out of which 5 taxa, *Mackenziea violacea* (Bedd.) Brem., *Nilgirianthus urceolaris* (Gambel) Brem., *Pleocaulis sessiloides* (Wt.) Brem., *Taeniandra micrantha* (Wt.) Brem. and *Strobilanthes tristis* T. Anders. apparently have not been collected since from the Nilgiris.

i. **Didyplosandra lurida** (Wt.) Brem. in Verh. Nederl. Akad. Wet. Nat. 41(1): 177. 1944. *Strobilanthes luridus* Wt.
November 1883; November 1886; February 1972; October 1972.

ii. **Leptacanthus amabilis** (C.B. Cl.) Brem. l.c. 184. 1944.
Strobilanthes amabilis C.B. Cl.
March 1883, November 1883, April 1884; January 1971, November 1971; October 1972.

* iii. **L. rubicundus** Nees in Wall. Pl. As. Rar. 3:90. 1832.
Strobilanthes rubicundus T. Anders.
November 1863; February 1888.

iv. **Mackenziea homotropa** (Nees) Brem. in Verh. Nederl. Akad. Wet. Nat. 41(1): 182. 1944. *Strobilanthes homotropus* Nees.
January, October and November 1883; April 1884; June 1970.

* v. **Nilgirianthus barbatus** (Nees) Brem. l.c. 173. 1944.
Strobilanthes barbata Nees.
November 1885.

* vi. **N. campanulatus** (Wt.) Brem. l.c. 172. 1944.
Strobilanthes campanulata Wt. No date is given on the sheet.

vii. **N. ciliatus** (Nees) Brem. l.c. 172. 1944.
Strobilanthes ciliatus Nees.
November 1885.

viii. **N. foliosus** (Wt.) Brem. l.c. 173. 1944.
Strobilanthes foliosa (Wt.) T. Anders.
November 1883; August 1885; May, July & August 1896; October 1956.

* ix. **N. heyneanus** (Ness) Brem. l.c. 173. 1944.
Strobilanthes heyneana Nees.
July 1883; November 1884; November 1885; November 1886; October 1887.

x. **N. neilgherresnsis** (Bedd.) Brem. l.c. 173. 1944.
Strobilanthes neilgherrensis Bedd.
November 1884; October 1972.

* xi. **N. popillosus** (T. Anders.) Brem. l.c. 173. 1944.
Strobilanthes papillosa T. Anders.
October & November 1883; April 1884; 1867; 1869.

xii. **N. perrottetianus** (Nees) Brem. l.c. 173. 1944.
Strobilanthes perrottetiana Nees.
June & November 1883; May 1885; July 1886; October 1956; June & July 1970; October 1972.

xiii. **N. punctatus** (Nees) Brem. l.c. 173. 1944.
Strobilanthes anceps Nees. var. *microstachya* (Benth.) C.B. Cl.
July 1970.

xiv. **N. warreensis** (Dalz.) Brem. l.c. 173. 1944.
Strobilanthes asper Wt.
September & November 1883; October 1884; October 1890; November 1891; October 1956; February & October 1972.

xv. **N. wightiana** (Nees) Brem. l.c. 173. 1944.
Strobilanthes wightiana Nees.
September 1882; August & November 1883; August 1886; September 1930; January, August & December 1957; July, August, September & December 1970; October 1972.

xvi. **Phlebophyllum kunthianum** Nees in Wall. Pl. As. Rar. 3: 83. 1832. *Strobilanthes kunthianum* (Nees) T. Anders. ex Benth.
May & September 1883; August 1886; October 1889; November 1890; September 1905; September 1930; September & October 1956; October 1957; March 1958; July, August, November & December 1970; July 1971; October 1972.

xviii. **P. lanatum** (Nees) Brem. in Verh. Nederl. Akad. Wet. Nat. 41 (1): 169. 1944.
Strobilanthes gossypina T. Anders.
November 1883; April 1950.

* xviii. **P. lawsonii** (Gamble) Brem. l.c. 169. 1944.
Strobilanthes lawsonii Gamble.
November 1883; April 1884.

* xix. **P. spicatum** (Roth) Brem. l.c. 169. 1944.
Strobilanthes consanguinea (Nees) T. Anders.
February 1885.

xx. **P. spicatum** (Roth) Brem. var. **amomum** (Nees) Brem. l.c. 169. 1944.
Strobilanthes consanguinea var. *amomum* (Nees) C.B. Cl.
January 1883; November 1884; February 1885; September 1970; December 1971.

xxi. **P. spicatum** (Roth) Brem. var. **hypoleucum** (Nees) Brem. l.c. 169. 1944. *Strobilanthes consanguinea* var. *hypoleuca* (Nees) C.B. Cl.
December 1970.

xxii. **P. versicolor** (Wt.) Brem. l.c. 169. 1944. *Strobilanthes cuspidata* (Benth.) T. Anders.
1873; January, June & November 1884; June 1885; January, August & November 1886; February 1890; October & December 1957; August 1970; January, April & November 1971; January & February 1972.

xxiii. **Pleocaulis sessilis** (Nees) Brem. l.c. 185. 1944. *Strobilanthes sessilis* Nees.
1878; August 1883; August 1886; September 1905; September 1918; September 1928; September 1930; July & August 1970.

xxiv. **Xenacanthus heteromallus** (T. Anders ex C.B. Cl.) Brem. l.c. 176. 1944. *Strobilanthes heteromalla* T. Anders. ex C.B. Cl.
May 1884; February 1885; February, March, October & November 1886; November 1970; January & April 1971; January & February 1972.

xxv. **X. pulneyensis** (C.B. Cl.) Brem. l.c. 176. 1944. *Strobilanthes pulneyensis* C.B. Cl.
October 1885; July & August 1886; November 1958; August & November 1970.

xxvi. **X. zenkerianus** (Nees) Brem. l.c. 176. 1944. *Strobilanthes zenkeriana* (Nees) T. Anders.
1868; 1873; September 1883; October 1884; 1886; October 1972.

BOTANICAL SURVEY OF INDIA,
COIMBATORE-2,
September 8, 1973.

J. L. ELLIS[1]
M. S. SWAMINATHAN

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[1] *Present address*: Central National Herbarium, Indian Botanic Garden, Howrah-3, (W.B.).

27. A NEW RECORD OF *MEINECKIA PARVIFOLIA* (WIGHT) WEBSTER FROM INDIA

During a study of the flora of Calicut, we came across a rare specimen, which turned out to be *Meineckia parvifolia* (Euphorbiaceae). As far as we know, this is the first report of this species from India. This is not described in any of the local floras and, therefore, a brief description of the species is given below to help its identification.

M. parvifolia (Wight) Webster: A perennial, glabrous herb with many weak branches; leaves about 3 × 2.5 cm alternate ovate, acute, truncate or rounded at base, membraneous, glabrous, green above, glaucous beneath, with 3-4 pairs of lateral veins, petiole filiform up to 2.5 cm; stipules minute, lanceolate; flowers in axillary monoecious clusters; female flowers solitary, terminal; males 1-3 below; pedicels filiform up to 2 cm. in fruits; perianth lobes 5, ovate or obovate obtuse, hyaline with green midrib, 1 mm long, slightly larger in female flowers, persistant; stamens in male flowers 5, filaments partially connate, anthers 2 celled dehiscing by a transverse slit, pistillode 0; ovary in female flowers subglobose, styles 3, spreading, deeply bifid, stigma capitate; fruits glabrous, 2.5 mm long; seeds flattened, brown, reticulate, 2 mm long.

Flowers and fruits: August - September.

Ackowledgements

We are very thankful to Prof. Grady L. Webster of the University of California for confirming the identification and to Dr. B. K. Nayar for encouragement.

Department of Botany,
University of Calicut,
Kerala,
February 20, 1973.

V. V. SIVARAJAN
K. S. MANILAL

28. ON FRESH WATER PHYTAL FAUNA OF VISAKHAPATNAM

Qualitative animal community studies of the aquatic vegetation are of recent origin. The fauna of fresh water weed *Eichhornia crassipes* was worked out by Michael (1968) from Barrackpore, India in a fresh water fish pond. Petr (1968) studied the fauna of *Pistia stratiotes* L. and *Ceratophyllum demersum* L. from man made Volta lake of Ghana. The only pertinent reference in the marine environment in India is

that of Sarma (1972). Omitting these references there are practically no published accounts evaluating the importance of the weeds as a biotope and their significance in the bioeconomy of the aquatic systems. The importance of the weeds in the studies pertaining to the biological productivity need not be overemphasized as they harbour varied and abundant life which forms the chief sources of food for the littoral fishes.

The ecological advantages of the phytal are that the weeds provide good amount of oxygen, a variety of hiding places from predators, abundant food supply, firm anchorage and protection from current velocity. It further serves as breeding ground for the spawning of certain organisms and as nursery ground for the young (Sarma 1972).

The present communication deals with the preliminary observations of the fauna associated with two fresh water weeds (*Chara* and *Spirogyra*) in a fresh water stream at Visakhapatnam, Andhra Pradesh.

Material & Methods

Samples of algae were collected and the quantitative estimation of organisms were related to unit volume/unit weight of the plant as was done by Ball (1948), Stube (1958), Michael (1968) and Petr (1968). Samples of algae were collected from the margins of the stream, transferred to polythene bottles and were brought to the laboratory. The samples were transferred to basins containing filtered fresh water for a general observation of the animals in the living condition. The displaced volume of the weeds along with the animals was taken by keeping the algae in a measuring cylinder of one litre capacity containing known volume of filtered water. After preliminary examination of the living animals they were fixed in 10% formaldehyde solution and throughly shaken to remove the majority of the clinging animals. To make sure that all the adnating and clinging life was removed, small amounts of algae were taken in a petridish and were throughly combed with a needle under a binocular microscope. The animals thus separated were counted under a stereo microscope with incident illumination. The wet weight of weeds was taken after removing the external moisture by pressing the algae in between the two folds of a blotting paper. The biomass values of two important groups namely oligochaetes and chironomids were also calculated. A minimum of 12 individuals of each group were kept in a hot air oven at 60°C temperature for about 24 hours. They were weighed in a microbalance. The individual weight of each animal was calculated and was multiplied by the total number of organisms of the group.

Observations

The numerical density and percentage composition of the animal populations inhabiting the *Chara* and *Spirogyra* per 100 gm wet weight of algae are given in the table. The maximum total animal densities on the two selected weeds (*Chara* and *Spirogyra*) were 6741 and 9175 organisms per 100 gm respectively. As many as 10 major taxonomic groups of animals namely turbellarians, nematodes, oligochaetes, copepods, ostracods, cladocera, hydrocarines, chironomids, insect larvae, and gastropods were recorded.

Table

Groups	*Chara* No/100G	*Chara* Percentage Composition	*Spirogyra* No/100G	*Spirogyra* Percentage Composition
Turbellaria	123	1.82	225	2.45
Nematoda	533	7.90	1925	20.99
Oligochaeta	1495	21.43	2175	23.71
Copepoda	500	7.41	775	8.44
Ostracoda	1198	17.77	925	10.08
Cladacera	328	4.86	550	5.99
Hydrocarina	328	4.86	150	1.63
Chironomida	974	14.44	1025	11.17
Insect larvae	369	5.47	975	10.62
Gastropoda	943	13.98	450	4.90
Total	6791	99.94	9175	99.98

Among the *Chara* fronds oligochaetes (1495), ostracods (1198), chironomids (974), gastropods (943), nematodes (533), and copepods (500) were dominant comprising more than 70% of the total fauna. Among the *Spirogyra* thalli all animal forms attained their maximum abundance. However while all other animals attained maximum numbers among the *Spirogyra* filaments, the gastropods and hydrocarines were found in their greatest abundance among the coarse, cushion type thallus of *Chara*. This may be a case of specificity for these two groups of animals. Further studies on the specific relations of algae and animals are under progress.

The biomass values of the two selected groups (oligochaeta and chionomidae) were high in the case of *Spirogyra* as shown below.

	Chara	*Spirogyra*
Oligochaeta	173.4 mg/100g	261.0 mg/100g
Chironomidae	730.5 mg/100g	891.7 mg/100g

The maximum total density found in the present studies is more or less comparable with that of Michael (1968) who observed a density range 9000 to 11200 per litre of *Eichhornia crassipes*. The high

numbers observed on *Eichhornia* may be due to its root systems which carries good amount of sediment which in turn acts as an incentive for the colonization of detritophobus fauna.

ACKNOWLEDGEMENT

We are thankful to the authorities of the University for providing the necessary facilities to carry out the present work.

DEPARTMENT OF ZOOLOGY,
ANDHRA UNIVERSITY,
WALTAIR, A.P.,
October 17, 1973.

A. L. N. SARMA
C. GOPALA SWAMY

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29. DIATOMS OF NAINITAL

The collections were made during a botanical excursion in October 1970 and were preserved in 4% formalin. The diatoms were cleaned by treating them first with concentrated hydrochloric acid and then with concentrated sulphuric acid to which a few crystals of potassium dichromate were added.

In this preliminary note seventeen common diatoms belonging to seven genera are included. Of these one belongs to the order Centrales while the remaining sixteen belong to Pennales. The dominant genera are *Cymbella* and *Gomphonema.*

Cyclotella kuetzingiana Thwaites
Diam. 9.6-12.8 μ ; striae 10-12 in 10 μ
In Naini lake and in a pond.
Synedra ulna (Nitz.) Ehr.
L. 62-106 μ ; B. 6.4-9.6 (at tip 2-3.2) μ ; striae 10-11 in 10 μ.
In pools and puddles.
Navicula cryptocephala Kuetz.
L. 32-49 μ ; B. 6-6.5 μ ; striae 12-18 in 10 μ.
In Naini lake.
Caloneis silicula (Ehr.) Cleve
L. 48-53 μ ; B. 10-13 μ ; striae 16-18 in 10 μ.
In pools and puddles.
Gomphonema aequatoriale Husted
L. 27-43 μ ; B. 6-11 μ ; striae 10-13 in 10 μ.
In pools and puddles.
G. gracile Ehr.
L. 40-42.5 μ ; B. 8-8.5 μ ; striae 9-10 in 10 μ.
In Naini lake.
G. olivaceum (Lyngb.) Kuetz. v. **calcarea** Cleve
L. 50-52 μ ; B. 10-11.4 μ ; striae 12-13 in 10 μ.
In a pool.
G. parvulum (Kuetz.) Grun.
L. 35-41 μ ; B. 9-9.6 μ ; striae 12-13 in 10 μ.
In pools and in Naini lake.
G. sphaerophorum Ehr.
L. 30-40.5 μ ; B. 10-11.3 μ ; striae 10-11 in 10 μ.
In Naini lake.
Cymbella aspera (Ehr.) Cleve
L. 84-90 μ ; B. 26-28.6 μ ; striae 6-8 in 10 μ.
In a small pond.
C. hustedtii Krasske
L. 17.6-18.8 μ ; B. 6.4-7 μ ; striae 12-13 in 10 μ.
In a puddle.
C. kerkevarensis A. Cl.
L. 20-22 μ ; B. 7-8 μ ; striae 11-12 in 10 μ.
In a pool and in a small pond.
C. rupicola Grun.
L. 30-40 μ ; B. 10-12 μ ; striae 12-14 in 10 μ.
In a pool.
C. tumescens A. Cl.
L. 28.8-32 μ ; B. 8-9.4 μ ; striae 10-12 in 10 μ.
In Naini lake.
C. tumida (Breb.) V. H.
L. 57-62 μ ; B. 18-19.5 μ ; striae 11-12 in 10. μ.
In puddles and in Naini lake.
C. tumida (Breb.) V. H. f. **ventricosa** Gandhi
L. 68-72 μ ; B. 19-20.5 μ ; striae 10-13 in 10 μ.
In a small pond.
Nitzschia amphibia Grun.
L. 19-22 μ ; B. 4.5-5 μ ; striae 15-18 in 10 μ ; punctae 17-21 in 10 μ
In pools.

ACKNOWLEDGEMENT

We take this opportunity to thank Dr. R. S. Nadkarni of this department for kindly collecting the algae.

BOTANY DEPARTMENT,
INSTITUTE OF SCIENCE,
NAGPUR,
July 15, 1973.

N. D. KAMAT
RITA AGGARWAL

ERRATA

Vol. 70 (2) — Miscellaneous Note No. 25, on p. 412
The name of the junior author
'P. R. FERNANDEZ' *read* 'R. R. FERNANDEZ'.

Vol. 71 (1) — Miscellaneous Note No. 6, on p. 144, in the 3rd para, line 1
'Primaries 2 to 8 (counting from the proximal end) had recently completed their growth'

read

'The inner seven (counting from the proximal end) primaries had recently completed their growth'.

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Keibul Lamjao Sanctuary and the Browantlered Deer—1972 with notes on a visit in 1975

Ranjit Sinh[1]

(*With two plates*)

There has been no investigation done of the status of this animal and its unique habitat since E. P. Gee's report of November, 1959 and March, 1960, in this *Journal* (1960). But it is certain that the Manipur stag (*Cervus eldi eldi* McClelland, 1842 is today one of the rarest and the most localised subspecies of the family Cervidae in the world. Zealously protected by the former rulers of Manipur State in the past, the stag was relentlessly hunted by both local people and army personnel once the area came under British hegemony. By 1950 the Manipur subspecies of the browantlered deer was regarded as extinct till located once again in a small area called the Keibul Lamjao at the south-eastern corner of the Logtak Lake. An area of approximately 20 sq miles was formed into a sanctuary in 1954, and was subsequently reduced to $10\frac{3}{4}$ sq miles in 1959. The other subspecies of the browantlered deer or Thamin in the Burmese subspecies (*Cervus eldi siamensis* Lydekker, 1915), the Manipur variety, locally called the *sangai* or occasionally

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sangrai, carries the smallest pair of antlers and has always been confined, even in historical times, to the vale of Manipur. At present, it is restricted to the Keibul Lamjao.

About 20 miles south of Imphal, the Capital of Manipur, lies the Logtak Lake, approximately 25 sq miles in extent, and famous for its fish and migratory waterfowl. There are floating islands or "Phumdi" on the lake, on which live fishermen in temporary huts. It is one of the largest natural lakes in the country, and forms a vast inland drainage area. South of the Logtak Lake and separated from it by the Thanga Hills, lies another low lying swamp called the Keibul Lamjao. Its eastern boundary is the Manipur river which drains the Logtak and indeed the entire vale of Manipur, ultimately joining the Chindwin river in Burma.

To the east of the Manipur river, is another marshy area called the Khoidum Lamjao,—rather larger than Keibul, which had its own population of the deer. This area is now reclaimed and cultivated, and the Sangai have been destroyed, a few of them crossing over into the Keibul sanctuary. To the west of the sanctuary and below the western hills of the Manipur valley was another Sangai area centring around a village called Sangailou (the Sangai paddy fields). Now this region also has been cultivated. In effect, therefore, the Sangai has been now restricted completely to the Keibul Lamjao Sanctuary and even here its habitat has shrunk.

Between 1959 to 1968 the area of the sanctuary was $10\frac{3}{4}$ sq miles. In 1968 a further 3 sq miles of the area north of the Khordak River, which drains the northern portion of the sanctuary, was added to the sanctuary, increasing the total area to $13\frac{3}{4}$ sq miles.

There are three hill features in the sanctuary. The northernmost is the Chingjao Hill, the Pabot Hill with the observation shed being a little to the south of this; and the third, Toya Hill, approximately 3 miles further to the south. There was much more vegetation on the Pabot Hill which I visited, than is shown in the photograph accompanying EPG's report of 1960. This proves that this area at least has been better protected since then. However, there is considerable grazing on Chingjao Hill which has practically no trees left. In fact, the entire portion of the sanctuary a quarter mile from the north-west of Pabot Hill is grazed intermittently, and there is cultivation and habitation on the Khordak River which bisects the northern portion of the sanctuary. These cultivations are illegal. Further to the south, there is a sickle shaped tongue of lowland called Thang-Brel-Maril which practically cuts the entire sanctuary into half. This is a strip about 300 to 500 yards wide, and though there are only about 4 or 5 official patta holders at the western corner of it, illegal encroachments continue to delve deeper and deeper along this strip of land. Though the area has been demarcated and there are boundary pillars, encroachment continues to

spill over these lines. Mostly paddy is grown, and from here cattle sally-forth and disturb adjacent regions. South of the Toya Hill and along the Khuga River north of Ithai village, there is more grazing by a substantial number of cattle, and the area is fast degenerating. The effective habitat of the Manipur deer is now confined to an area east and south of the Pabot Hill up to the Thang-Brel-Maril, and another area further south of this strip of cultivation extending up to Toya Hill.

Thus though the total area of the Keibul Lamjao Sanctuary is $13\frac{3}{4}$ sq miles, the real habitat of the Manipur deer does not exceed 6 sq miles, and this too is under imminent danger of being divided into two halves. The total world population of the subspecies is now confined to this last tenuous habitat, and at the rate at which encroachment and grazing is increasing, if no urgent steps are taken to reverse this process and to safeguard the sanctuary, the Sangai will be extinct very soon. It is evident that the prime reason for the survival of this unique deer in this heavily populated area is the floating swamp. If the swamp (or phumdi) goes, the deer will vanish with it.

Status of the Sanctuary

The Keibul Lamjao Sanctuary is a protected forest today. There is not even a proposal to make it into a reserve forest for the time being. In my opinion this should be done forthwith as it will give the Forest Department the right of removal of any encroachers. The sanctuary has been notified in the gazette in 1966 and its boundaries have been outlined. It is under the Eastern Forest Division of Manipur, with range headquarters at Moirang.

Climate:

The average annual rainfall is approximately 125 cm. The humidity is highest in the month of August at 81 per cent and lowest in March at 49 per cent. The maximum temperature is 35°C and the minimum 1.66°C. Frost occurs during the winter.

Flora:

Apart from the three hills of Pabot, Toya and Chingjao, the remainder of the sanctuary is one vast morass of floating organic matter called the phum or phumdi. A passage of free water for boating up to Pabot Hill, has been cleared. The phumdi is made up of decayed vegetation, and varies in thickness from 1 to 4 feet. It floats upon the water, whose level varies with the season. Thus during the driest months of February and March, some of the phumdi especially along the edge of the sanctuary, rests on the hard ground below. Actually only 1/5th of the phumdi shows above water, the rest being below it. The floating islands are a

growing organic unit and the thickness of the phumdi increases from year to year. This is particularly applicable to the phumdi which during the summer season rests upon the ground. With onset of the monsoon, the major portion of the sanctuary gets covered with water and the animals seek refuge on the hills. Then in approximately three or four days the phumdi which had settled on the ground, sets itself free and once again floats on the top of the water. In 1966, there were heavy floods with the water level rising to an unprecedented height of 2531 feet above msl. The phumdi got carried away with the current and with it went a certain number of the deer.

Walking on the phumdi is a unique experience—as if one was walking on an air-mattress. Where the phumdi is not thick enough to support the weight, one can sink up to one's thigh in the ooze—and this happens every few steps.

The reeds and grasses which grow on the phumdi, and the ratio thereof, are listed in E. P. Gee's account. Since I myself did not carry out a detailed investigation in this regard, Mr. Gee's list is reproduced below:-

"Tou	*Phragmites karka*	45% of the sanctuary
Singut	(not yet identified)	25%
Khoimum	*Saccharum munja*	15%
Ishing Kombong	*Saccharum latifolium*	5%
Pulai	*Alpinia allughas*	5%
Singnang	*Saccharum procerum*	2%
Miscellaneous		3%"

The Ishing Kombong (*Saccharum latifolium*) is the favourite food of the Sangai and is relished even by the hind which was in captivity at the Keibul chowki. Secondly, the percentage which it occupied in the sanctuary, if not 5 per cent as E. P. Gee's reports, would certainly not be more than 10 per cent. An adequate supply of the Ishing Kombong grass is essential for the conservation of the deer and the matter becomes more significant when it is realised that it is also a favoured food of the encroaching domestic buffalo.

As has been mentioned above, the phumdi becomes thicker and heavier with the passage of time with more vegetation being added to it each year. This process of annual increase is more evident in the phumdi at the edges of the sanctuary, where it has the opportunity of settling on the ground for the longest period and thereby derives sustenance from the soil below. If for two to three years consecutively, there is no heavy flooding, this bordering phumdi would not be forced to leave the ground to float. It will become a part of the hard ground as humus. The factor of trampling by domestic buffalo during the dry season would also, I am sure, help in pressing the phumdi to the hard

ground below and making it a permanent fixture thereupon. The ultimate result of such a process is that the phumdi at the border becomes hard ground with the passage of time, and the actual area of the floating phumdi decreases. It is this process which decreases the floating phumdi habitat of the sangai in the Keibul Lamjao. Water Hyacinth has made its appearance in the open water areas of the sanctuary, but this being very limited it has not yet reached significant proportions in the sanctuary. The three hills within the sanctuary are not only very important observation points in the sanctuary, but constitute a very significant factor in the eco-system. They are the only hard ground in the sanctuary to which the animals can repair to from time to time. Though the sangai has adapted itself admirably to the phumdi habitat, the alacrity with which the captive sangai move over hard areas and hilly ground and the fact that it used to inhabit other non-phumdi areas is evidence enough that unlike the situtunga, the sangai is not exclusively a marsh animal. The fact that they regularly visit the hills is proved by their droppings there. Other animals such as the hog deer also use these hills, which during the floods provide the only refuge for the larger mammals of the sanctuary. All the three hills should be strictly protected from grazing and other exploitation and trees and shrubs should be allowed to grow there. Simul and other indigenous trees like *Salix tetrasperma* may be planted, especially on the now barren Chingjao Hill, but no exotic should be introduced.

Exploitation:

The right of grass cutting is auctioned each year in the months of March and April for approximately Rs. 2,000/-. The singang grass is utilised for thatch purposes. Burning occurs during the dry season and is reported to be accidental. However, it is possible that some of these fires, at least on the periphery are caused by graziers to obtain fresh grass.

Grazing:

It is most prevalent in the northern and southern part of the sanctuary and around Keibul village has succeeded in degenerating these lands. Only buffaloes are able to traverse the marsh though a few cows were seen grazing along the periphery. Some buffaloes were observed in the centre of the sanctuary just south of the Pabot Hill in the best sangai area. Though no cutting of trees was noticed, the fact that Chingjao Hill has no trees and that Toya Hill also has rather sparse vegetation, is an indication that there is grazing and cutting on these two hills.

I was informed that approximately 100 people cut grass in the sanctuary every day. Certain plants are collected for consumption as vegetables. Fishing in the open patches is also indulged in, and I saw a number of fish traps along the channel leading to Pabot Hill. Apart from

the grass cutters, fishermen and the graziers, some people pass through the sanctuary on their way to Khordak and the Logtak for purposes of fishing.

Poaching does occur in the sanctuary, especially in the northeastern region. The poachers use shot guns and drive the deer with dogs. A wooden trap which resembles a yoke is also used. The main offenders are from the Muslim community whose population around the sanctuary has increased. To a certain extent poachings is also done by the tribes such as the Kukis who live to the south of the sanctuary. Luckily the Hindu population is mostly vegetarian. However, the Muslim community possess a large number of weapons, and the crop-protection weapons are issued to the land-owners including those occupying land in the Thang-Brel-Maril. Poaching and habitat destruction are the two significant causes for the present precarious status of the sangai. Most of the poaching occurs from March to May during the dry season.

The remains of a young hog deer was found on Pabot Hill, but its cause of death could not be ascertained. A hog deer stag was reported to have been killed by poachers in north-west part of the sanctuary a few days before our arrival.

Fauna:

The browantlered deer:

E. P. Gee had carried out a sample survey of an area of a quarter sq. mile, and from the deer counted in this patch, he had estimated that the total population was 100. I was only able to see one stag from Pabot Hill and was told that I was lucky. A drive was attempted in a small patch at the southwestern corner of the sanctuary close to Thang-Brel-Maril. No deer was put up. Despite the fact that some of the deer which must have then lived in Khoidum-Lamjao across the Manipur river, and which subsequently must have crossed to Keibul Lamjao following the opening of that area for cultivation, the number of sangai today is less than that when E. P. Gee visited in 1960. This was confirmed by Babu Singh the most knowledgeable amongst the staff of the sanctuary. The reason is primarily poaching, and secondly the further shrinking of the habitat due to grazing, cultivation and grass cutting. The floods of 1966 in which the phumdi was swept away from certain areas, must have also contributed to the decimation. The total area which would now be fit for sangai habitation would only be about 6 sq. miles as has been mentioned above, and unless the process reverses, it will shrink still further. The largest number of sangai reported to have been seen together recently is five and the usual number are ones and twos. Though it is not possible to assess correctly the total population in such a habitat, I would certainly put the figure as less than 100. More in the neighbourhood of 50. It is imperative that a census of this animal be carried

out, and the only way it can be done is from a helicopter flying low over the morass.

Hog-deer (*Axis porcinus*) occur in the sanctuary and their droppings were observed on Pabot Hill. Wild pig also exist and raid the surrounding crops. Their droppings were seen. A wild cat locally called "Sadung" was reported in the sanctuary. From its description it appears to be a civet of an indeterminate variety.

Staff:

The sanctuary is under one deputy ranger, three forest guards, one game chaprasi and one boatman, and two daily-wage employees working as boatmen. This very small staff is stationed at three points Keibul to the west, Ithai to the south and Paphu-pat in the east. They have residential accommodation. The staff is wholly inadequate and would have to be greatly augmented.

Residential Accommodation and facilities for Tourists:

There are two rest houses—one at Phubala off the Imphal-Moirang road. It is situated close to the Logtak lake and has 4 rooms with two beds each, quite well furnished. It is under the control of the Publicity Department and the charges are Rs. 3/- per day. There is no catering arrangement. The rest house is electrified but there is no running water. It is a beautifully situated bungalow and could be developed. There is another rest house at Sendra on the Thanga Hills that commands a magnificent view of Logtak Lake as well as the southern aspect of the valley. This also has 4 suites, but was under repairs. There are no vehicles for tourists to hire. The only method whereby tourists can visit the sanctuary is to go up to Keibul by road and then along the water channel in dug-out boats upto Pabot Hill, where there is an observation shed. (Plate I). Usually, mornings and evenings are preferred and if the visitor is lucky he may see from the hill top the deer moving about on the phumdi. The view from here is magnificent but the chance of seeing deer are remote. If driven out by beaters, deer can be seen from the hill tops, but walking on phumdi is very difficult and the villagers are not keen to undertake the job. Besides, such regular drives would be a great factor of disturbance to the deer and should not be normally practised.

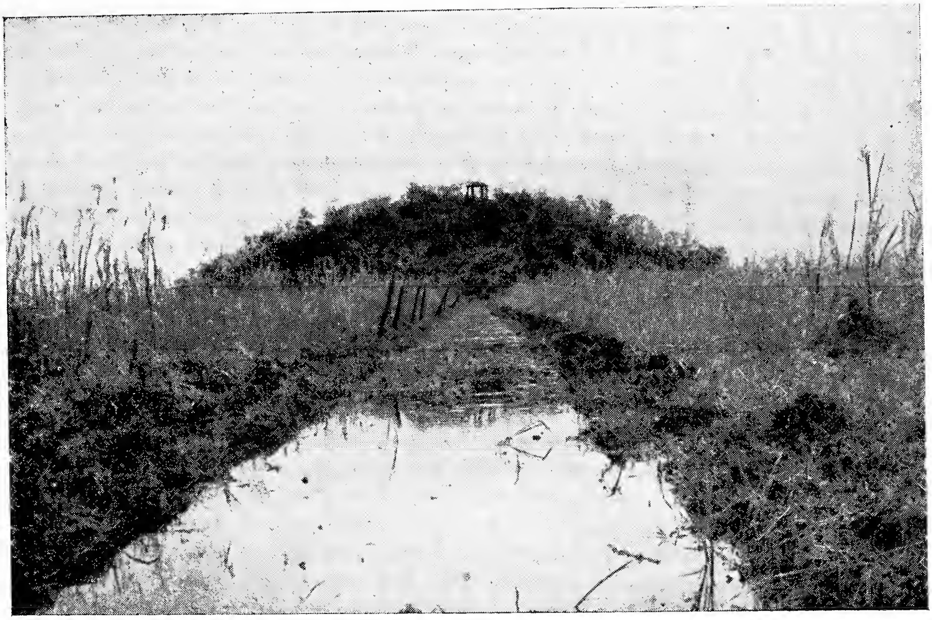
The Logtak project:

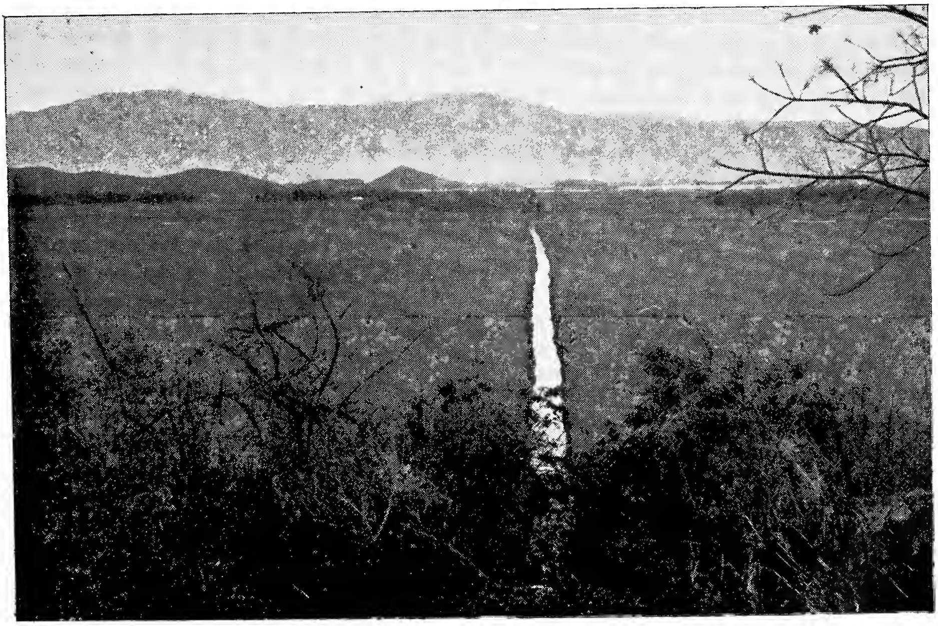
A coffer dam is being put up below the junction of the Khuga and Manipur rivers, south of Ithai village and approximately half a mile below the southern tip of the sanctuary. The gate of the Ithai dam will be 2525 feet above main sea level. This will therefore, be the height of the water in the Logtak Lake; and since the Logtak is connected with the Keibul Lamjao through two channels running through the Thanga Hills, the water table of the Keibul Lamjao will also be 2525 feet above msl. The surplus water of the Logtak which would have otherwise

spilt over the dam at Ithai, would be diverted through a channel running west-ward from the Logtak. This water will then go through a tunnel in the western range of hills, and a drop of thousand feet, will generate 35 Kw of power.

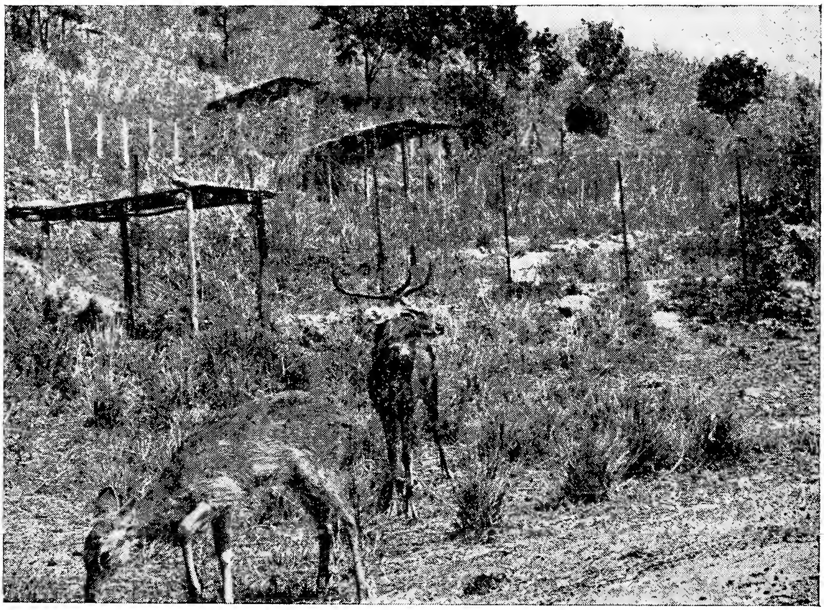
The height of the water in the Logtak Lake and in the Keibul Lamjao varies from 2518 to 2528 feet above msl. The lowest level is in February-March, the highest of course being during the monsoon. In 1966 the water level of the flood waters rose to 2531 feet above msl as a result of which some phumdi is reported to have been swept away. Now the water level is sought to be retained at 2525 feet constantly. The danger of a flood has been averted as the river is being widened. In the dry season the water level of the Logtak and the Keibul sanctuary would not also go down to 2518.

At the height of 2525 feet above msl, the area under water in the Keibul sanctuary will increase. Since the level is going to be retained at that height, the extent of the phumdi habitat would also theoretically remain constant. The phumdi will not settle on the ground in the dry season and the predilection for becoming heavier and heavier and finally settling on the hard ground would be lessened. The cattle and the poachers will not be able to make their inroads during the dry season to the extent they do now. The total area of the phumdi will increase and its extent would be retained at a contour of 2525 feet msl which is achieved today only during the monsoon and post-monsoon period. On the face of it, therefore, it would appear that maintenance of the water at a given level would prevent further decrease of the sangai habitat and make poaching more difficult. Indeed, it may even be that the habitat of the sangai would be increased with the constant water level at 2525′ above msl. However, certain factors will have to be kept in mind. The Logtak Lake and the Keibul Lamjao with which it is connected, are a very complex aquatic eco-system. The disturbance of its ecology may have other complex and unforseen results. The project is almost nearing completion and it will not be possible and advisable to stop it. But a research be carried out on the ecological aspects of this project, indeed on the ecology of the entire Keibul Lamjao-Logtak complex. If any factor which proves to be adverse to either of the two, the project should be modified to that extent. Perhaps the lowering of the water table from 2525′ above msl, if such is proved to be necessary may have to be carried out. Certain other considerations may also have to be investigated. Now that the annual flooding and the lowering of the water table in the summer would not be permitted, what would be the ecological repurcussions? The phumdi which settles on the hard ground in the dry season would not now be permitted to do so. Would this have any effect upon its composition, and would the phumdi continue to flourish if it is not allowed to settle on the hard ground? In other words,





Above: View from the Channel of Pabot Hill. *Below*: West view from Pabot Hill.



Above: Deer seen from the Helicopter in 1975. *Below*: Captive deer in the enclosure at the Sanctuary.

is the periodic settling of the phumdi on the hard ground essential for its existence? It may be pointed here that phumdi is unique to the Keibul Lamjao, there being very few phumdi islands on the deeper and larger Logtak Lake close by. Moreover, water hyacinth has invaded the Logtak but not the Keibul Lamjao. There is hardly any open water in the latter. But with the water table at 2525′ above msl, would there be more open water and as a consequence more water hyacinth? A very significant and interesting factor is that the peak rutting period is in the month of February and March when the water level is at its lowest and the phumdi has settled on the ground, at least on the fringes. The coinciding of the rut with the dry season is not a coincidence in my opinion. And if this assumption is correct, would maintenance of the water table at 2525′ above msl adversely affect the rut. Do the animals mate on the floating phumdi or do they require hard ground.

Lastly, the Logtak project envisages the reclamation of the land between contours 2525 and 2528 feet above msl. This is supposed to be an area of 6000 acres. It must be made very sure that the area which is proposed to be reclaimed for cultivation between these two contours, is not from within the Keibul Lamjao Sanctuary.

Recommendations:

Manipur is the only part of India in which the Browantlered deer is found, and it is in fact the only habitat in the world where this particular subspecies occurs. To focus attention on this unique deer, it is suggested that just as Assam has declared the Rhino as the state emblem, the Manipur Government should declare the 'Sangai' as its state emblem.

2. The Keibul Lamjao Sanctuary should be declared a reserve forest and a National Park. This would not only give the State Forest Department adequate power to conserve this unique habitat, but will also set aside this small piece of territory as an area of national importance in which the State and Central governments could work in harmony to achieve a common goal.

3. An adequate wildlife legislation should be adopted. The Government of India has already approached the Government of Manipur for the adoption of the Central Wildlife Conservation and Management Bill. It is hoped that the Manipur Government will adopt this. The existing manual of "Preservation of Wildlife and Reserve Forest and other parts of Manipur" also needs to be revised.

4. The present staff of the sanctuary is totally inadequate. The following personnel is recommended for the sanctuary. One full time A.C.F., one ranger, 6 foresters, 10 forest guards, three boatmen and three game chaprasis. The A.C.F. with two foresters, two forest guards, one boatman and two game chaprasis, should be at Keibul. The ranger, with one

forester, two forest guards and one boatman, should be at Komla-Khong-north-east of the sanctuary. At Ithai one forester, two forest guards and one boatman be stationed, and at Khordak village one forester, two forest guards and one chaprasi. This staff is absolutely essential to prevent poaching and illicit grazing.

5. *Service rifles*—.410 muskets or .303 rifles for which cartridges are only available with the Government and not in the open market needs to be supplied to the Ranger and each of the Forest Guards. The Police Department of the State should make available these weapons, as has been done in some other States.

6. The poaching is done mostly with the help of dogs, and traps, and is usually from the north-east of the sanctuary. This will have to be effectively curbed and the poachers prosecuted. Poaching is most prominent in the dry season and if during this time additional staff is required, they could be provided on a temporary basis, to augment the permanent staff. This would be over and above the staff suggested above. The Forest Department should keep a copy of the license holders on the periphery of the sanctuary, and if anything adverse comes to notice, they could move the Government for the cancellation of the licenses.

7. The incidence of grazing is most from November to May. This must be stopped, specially in the northern region around the Chingjao Hill and to the south near Ithai village. As the grazing is mostly from the western, northern and southern sides, a trench could be dug from Thanga Hills to Ithai village to prevent the ingress of cattle. Not only do the cattle constitute a factor of disturbance but also pose a threat as the carriers of disease. One single epidemic is sufficient to wipe out the total world population of the Manipur stag today. Besides, as has been pointed out above, cattle is the main competitor with the Sangai for the grass Ishing Kombong which constitutes less than 10 per cent of the total grass in the sanctuary.

8. Other factors of human exploitation such as fishing, wood cutting on the hills, grass cutting and transit through the sanctuary, should be totally prohibited. Grass cutting only fetches Rs. 2000/- a year and this must be stopped.

9. No person should be allowed to enter the sanctuary without a valid permit from an official not below the rank of a Ranger.

10. Burning of grass should not be allowed in the sanctuary.

11. Illicit cultivation in the Thang-Brel-Maril should be done away with. If this is not implemented the sanctuary is in danger of being cut into two halves with disastrous results. Illegal settlements on the Khordak river must also be removed.

12. Prophylatic innoculation of peripheral cattle and buffaloes, specially the latter, be carried out intensively. In Pabot Hill it may be worthwhile to experiment by placing rock-salt. I am sure the deer would wel-

come this and apart from providing them with nutrition, it would also result in their being seen more frequently seen from this observation post.

13. No exotic plants or trees should be introduced or planted in the island or elsewhere in the sanctuary. However, the planting of indigenous trees should be carried out on the Chingjao Hill and to a lesser extent on Toya Hill.

14. A wooden observation tower should be put up at Toya Hill with a canal cut through the phumdi from the west. However, this should only be done when effective protection can be provided to this spot.

15. The A.C.F. to be placed in charge of the sanctuary should receive wildlife training at Dehradun.

16. Since the Keibul Lamjao and the Logtak lake are areas of inland drainage and being a complex aquatic eco-system, are extremely fragile, care should be taken to prevent any action which may endanger the eco-systems. Spraying of insecticides and pesticides which will immediately find their way into the lakes, should be prohibited at all cost, otherwise the entire life including the fish, may be jeopardised.

17. A detailed scientific study of the effects of the Logtak project on the Keibul Lamjao, needs to be started forthwith. The salient features of the investigation have been suggested before in this report. In fact there is urgent need to carry out a research on the ecology of the Keibul Lamjao; on its unique phumdi habitat, the deer and the aquatic life.

18. Since the Keibul Lamjao is today the only habitat of the brow-antlered deer, disease or a radical setback, not to mention the incidence of poaching, could wipe out the entire population of the deer. It is therefore, essential that a second suitable home for this deer should be set up in the valley of Manipur itself. This could be in the Khoidum Lamjao (what now remains of it), or any other suitable habitat in the valley. The Forest Department may make investigations in this regard —where a second sanctuary could be created wherein a small breeding group of the sangai could be released at a later juncture.

However, to augment the present low population of the deer in the sanctuary, to enable research on the deer in at least a semi-captitve stage, and to provide an added attraction to visitors, a captive breeding programme of the brow-antlered deer on its own habitat, is imperative. At present there is an enclosure which is behind the Keibul forest office in which a hind is kept. Though this is a fairly large enclosure, there is no phumdi nor marsh in it. An ideal enclosure would be one in which a part of the phumdi is enclosed as well, as a certain portion of the hillside to which the animal could move over when they wish to be on hard ground. Such an enclosure could be situated on the Ching-mei Hill southeast of the Keibul forest beat-office. Here the hind held in captivity could be released, and a herd of two stags and three hinds

could be brought over from the Delhi Zoo for breeding purposes. These deer in the Delhi Zoo are the progeny of the sangai which were captured from the Keibul Lamjao some years back. Browantlered deer breed well in captivity and I am sure if properly looked after, and if attached to a research project, they could form a nucleus for an effective captive breeding project.

The Sanctuary in March 1975

I visited Keibul Lamjao after a lapse of three years in 1975. Considerable progress has been made since my earlier visit at the instance of the Government of India, and due to the keen interest now being evidenced by the Government of Manipur.

I took the opportunity of the presence of the Pre-Investment Survey helicopter in Manipur to carry out an aerial survey of the population of the deer, this being the only feasible way of counting them in the impenetrable floating morass. March being the height of dry season, the "phumdi" had been set on fire by the surrounding villagers and fresh green grass was sprouting. The deer could therefore hide only in the remaining patches of dry grass which made the counting easy (Plate II). I flew low over the Keibul Lamjao for a period of about 45 minutes, and the number of deer revealed was far below even the most pessimistic estimate. *There are only 14 Manipur Browantlered deer left in the wild,* 5 stags, 6 hinds and 3 fawns. This makes the Manipur deer the most threatened animal in the entire sub-continent, and amongst the half a dozen most endangered species in the whole world.

It is fortunate that this species breeds well in captivity and we have a viable herd in the Delhi Zoo, and have given them to other reputable zoos in the country for breeding purposes. However, if the deer are to survive in the wild, and if the captive breeding stock is to be rehabilitated in the wild, it is imperative that the Keibul Lamjao Sanctuary must be preserved at all costs. This is the only suitable habitat left for this deer in the valley of Manipur. I have been advocating the acquisition of a suitable territory for the deer on the other side of the Manipur river where they once lived. This is now in private hands and can be acquired for the deer if the Manipur Government so deems fit. However, the primary task is to preserve absolutely the existing habitat in the Keibul Lamjao Sanctuary.

All grazing and fishing inside the sanctuary must be stopped. I saw more evidence of grazing and fishing in the sanctuary in March, 1975 than was the case in March, 1972. If necessary, this should be done by putting up a physical barrier for which funds have been provided to the Manipur Government, and which have not been utilised so far.

The cultivation within the sanctuary, especially in the Thang-Brel-Maril strip which bisects the sanctuary almost into two, should be prohibited. In case where the property rights have been given over to the cultivators, these lands should be acquired, for which Government of India can meet the cost of acquisition under the scheme of Financial Assistance to Selected National Parks and Sanctuaries, and under which we are already providing funds to the Keibul Lamjao.

No person should be allowed into the sanctuary without a valid permit from the officer in charge, and this would preclude the entry of regular parties of villagers who enter the sanctuary to collect grass and wild vegetables.

Protective staff to be augmented and posted at strategic points on the periphery of the sanctuary. *At least four Home Guards units should be posted on the periphery to patrol the area with the forest staff.*

Weapons given to the villagers on the periphery especially on the eastern side of the sanctuary, are regularly mis-used for the poaching of deer with the help of dogs. All these weapons should be withdrawn and the licenses cancelled.

Repeated prophylactic innoculations should be carried out on the cattle of the periphery for preventing cattle disease from affecting the remnant population.

The sanctuary should be upgraded into a national park and the boundary of this park should be the contour 25 25′, which will be the level of the water when the Logtak project is completed, and lastly, as has been discussed above, the raising of the water level due to the Logtak project will have certain obvious advantages. However, if the constant maintenance of the water at the level of 25 25′ is to have a deleterious effect on the ecology of the Keibul Lamjao Sanctuary and the formation of the floating islands which are the very raison d'etre of this sanctuary, the level of the water held by the dam on the Manipur river would have to be manipulated so as to restore the ecological factors prevailing prior to the building up of the dam.

It must be emphasised that the Manipur deer and the Keibul Lamjao Sanctuary on which it is existing, are in a desperate situation and unless the matter is given very urgent priority, there is no doubt that this beautiful deer will become extinct in the wild, in the very near future.

The Mountain Hawk-Eagle[1]

S. M. OSMAN[2]

I was resting on a high stretch of the Theri-Mussoorie road one morning, where it marks the northern boundary of the Motidhar shooting block, when I noticed an eagle spiralling up from the plains. Soon it was flying level with the road and passed so close overhead that I could see each detail. To a falconer it was a real beauty, handsome and very large. Without a single wing-beat, it glided towards a rocky out-crop, perching as delicately as if its huge bulk were without weight. It was not more than a hundred and fifty yards away, and I had to act quickly.

I hissed at my servant to produce the dogaza and live pigeon that always accompany me to out-of-the-way places, and set my trap in a terraced field just below the road. Then we hid and prayed.

Soon the eagle dived in a most spectacular fashion straight into the net, and no mother could have shown greater love or gentleness towards her first-born than I felt towards this tigress from the sky as I freed her from the net. My permit expired that day and I had intended to shoot some more pheasants before catching the last bus at Sahastradhara, but now I decided to head for the taxi-stand at Mussoorie. I had no hood with me, but was able to borrow needle and thread in Soakholi, the first village I came to, and after I had sealed its eyes the eagle was calmer.

Before I proceed to narrate the obstacles my father and I had to overcome before this eagle was trained, and some of the incidents in the six happy years we hunted with her, let me attempt a more general description of the Mountain Hawk-Eagle, *Spizaetus nipalensis*.

In immature birds the head is dark brown, but the feathers on top of the head are edged with light cinnamon. The colour changes to a darker shade with each successive moult, so that in old birds the head is almost black. In addition, dark moustachial stripes are developed. On top of the head is a long crest, the feathers of which are tipped with light cinnamon, or in older birds with almost pure white. The back and upper parts are light chocolate, becoming dark brown after a few years of moulting. The wings are barred with dark chocolate, and the tail-coverts barred with white. The tail pens are of a light olive-grey colour with dark brown bands running across.

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[1] Accepted April 1973.

[2] No. 11-D/10 Circular Road, Dehra Dun, U.P.

In juvenile birds the general colour scheme is of a light or pale shade. The wing-covert feathers in all such birds have almost white edges. All immature birds have a salmon patch below their chins. In older birds this patch is cleft by a dark brown streak, which tends to broaden with each moult and also to become more and more dark till it appears almost black in birds that are more than six years old. This streak reaches down till it almost touches the crop. The underparts appear to be white or almost so. In such birds the breast is pale cinnamon in colour, and is streaked with light brown feathers that extend to well below the crop. From here downwards, white barrings are found right to the belly. In older birds these broken white bars touch the crop of the eagle, and are well pronounced. Streaks that in immature birds are of a light brown shade change to a dark brown colour after a few moults. In young birds, the tail pens seem to have more numerous and narrower bars running across them.

In an unusually long head, that is very conspicuous in the female birds, is set a black beak. In juvenile birds, the eyes are yellow, but with advancing age the colour changes to a deep orange. The toes are usually of a faded yellow shade, but the colour depends on the food the eagle has been eating, as some birds killed by an eagle are not always as nutritious as rodents such as hares, squirrels and hamsters. Food that is rich in fat and vitamin B_{12}, if fed to the eagle or any hawk for some length of time, will change the colour of the toes of that predator to a bright yellow. This indicates very good health. In these eagles, the feathers on the tarsi not only come down as far as the toe-joint, but grow in between the toes as well. By looking at the extreme limit of the feather range on the tarsi of hawk-eagles it is easy to differentiate between *nipalensis* and *cirrhatus*.

This eagle has the most formidable claws to be seen in birds of its size and weight. On the other hand, its beak is not as broad-based as Bonelli's. This slender beak in no way impairs its efficiency as a big killer of game.

Male birds rarely go above twenty-five inches. Females may measure thirty inches or more at times.

In the Himalayas, *nipalensis* keeps to the higher ranges and prefers forested slopes. Because of snow, and cold, and also because other birds such as pheasants migrate to the foothills during winter, *nipalensis* also is obliged to come down to the plains, when it may be seen as far down as the lower reaches of the Siwaliks. In its winter habitat it still prefers wooded areas, especially where peafowl and junglefowl abound. Beyond the Siwaliks, it has seldom been reported, and on the whole it is seen to prefer the mountain fastness of the mighty Himalayas, where it breeds. It is the most voracious raptor, for its size, that I have seen. It kills a huge variety of game, taking both big and small birds with ease.

It also kills and eats hares, squirrels, an occasional stone marten, and flying foxes the large fruit bats that are found in the Doon Valley. Large birds that are frequently taken are peafowl, chir and monal pheasants, junglefowl, and waterfowl such as the greylag goose. The smaller birds include partridges, wood pigeons and even swift parakeets. Since most of these birds are taken on the wing some idea of the speed this eagle is capable of achieving can be formed. I am convinced, and my conviction is probably shared by quite a number of falconers and naturalists, that *nipalensis* is the fastest eagle on the Indian subcontinent.

In flight it is graceful, showing an enormous degree of manoeuvrability. When our eagle had been fully trained I had ample opportunities of watching her when flown after nightjars. This fly-by-night is no easy prey even for the fast sparrow-hawks, but our eagle would capture it on the wing nine times out of ten. The nightjars, or goatsucker as it is sometimes called, is remarkable for its powers of flight and great speed. It twists and turns in mid air so effortlessly that it is amazing just to watch it perform.

In all my years of wandering in the hills I have come across only three *nipalensis* nests. One of these was not far from a village close to Mussoorie. In early spring I am often gripped by restlessness. At such times I drop whatever work I have on hand, and with rucksack and valise strike for the hills or the forests. Then, after a few days of aimless roaming around in the wilderness, I return home, once again a contented man. In March the hills to the north of Dehra are a veritable paradise, and if you go to the right places you will find the countryside teeming with wild life, especially birds of all kinds, including local migrants that each year return to their old nesting sites. Most of the bird population is busy either courting or building a nest, but the Mountain Hawk-Eagle completes these preliminaries in January, and in March is settling down to the more serious business of incubation and egg-hatching.

The village I am speaking of stood near a terrifying precipice, cocked at such a dizzy angle on the slope of the hill that just to reach it was sufficient to put the fear of God into the heart of any plainsman. Bang on the edge of the precipice, and no more than twenty yards from the cluster of huts that make up the village, there stood a towering pine tree. In the village lived hillmen with their families, buffaloes, and goats, all in the same huts. A rickety cot had been pulled out of one of the huts for me, and as I sat talking to the headman I heard the unmistakable *Kwick Kwick* call of an eagle coming from the direction of the giant pine. Immediately I was on my feet, and in order to get a better look at the nest I climbed up the hill for a hundred feet or so, enough to put me level with the nest. It was about ten feet below the top of the

pine tree, and in full view from where I stood. I watched the male bird leave the nest, and the female eagle, which was the bigger of the two, settle down to incubate the eggs. I sat there for almost an hour in the hope of getting a better glimpse of the contents of that nest, but no amount of shouting or clapping would make the hen bird leave the nest even for a short while. In fact my efforts had just the opposite result, for thereafter she crouched lower in the nest with her head barely showing above the rim. From this behaviour I concluded that there must be eggs, though I did not know how many.

Two months later I returned to the village hoping to see the eaglets in full glory. But I could see no nest and the headman told me that it had been blown down in a terrific storm, some weeks after my last visit. I was inclined to believe this as no one could have molested the nest since the tree stood on the brink of an abyss, and even getting near the pine was enough to make my head reel.

I came across a second nest at a place in Uttar Kashi in the Garhwal hills. Here I had an excellent view of the two eaglets, as they used to stand up in the nest whenever the parents came to feed them. What struck me as odd was that the parent birds were not of the same age. The male eagle was an immature bird, for I could clearly see the white edges of the feathers on its wing-coverts, and I had been under the impression that immature birds did not breed. The female eagle was unusually big, and from the darkness of her colour appeared to be six or seven years old. The chin stripe referred to earlier was most conspicuously drawn under her chin.

I was able to watch the nest to my heart's content for two whole days, and could see not only the eaglets, but the parent birds too as they came with food for their offspring. I was fascinated to see the female bring home sometimes a lizard, sometimes a hill partridge or chukor, and once a blue rock pigeon. It was touching to see the tender care she exercised in feeding the eaglets. The nest itself was an untidy pile of sticks high in a huge tree. I found the eaglets were being fed at all times of the day by the parent birds, and one of these would always be on hand to defend the nest and eaglets against marauders. It was so well guarded that ravens and kites gave it a wide berth. There was quite a lot of wing-flapping and screaming by the eaglets when one of the parents flew home with food.

The third nest was at Binahar in the western Doon valley, about 5000 ft above sea level. As I was walking at dusk across a terraced field I saw an eagle fly out of the only oak tree at the far end. My host told me that there was a nest, and that the eagle could be seen flying in and out of it many times during the day, so next morning I walked over and had got quite close to the tree before the eagle decided to fly away. I was easily able to see she was a female Mountain Hawk-Eagle, some five

years old. The nest was untidy, but not very big, and was placed not more than thirty feet from ground-level. From this I concluded that the nest had not seen many years of tenancy, and must have been built a year or so ago. I did not see the male bird, but I did not stay at the nest site for more than a few minutes, and probably he was either out hunting, or on the other side of the ravine. When I inquired about the nest again, a couple of years later, I was told the oak tree had been cut down.

I have seen these eagles in Naini Tal and am sure they extend over the entire Himalayan range. I don't think they spread into Kashgaria, but they do reach Assam, and on to Burma. A planter friend in Assam once showed me the skin of an eagle he had shot in the hill ranges of southern Bhutan, and on examination I found it to be the skin of a Mountain Hawk-Eagle. Accounts of naturalists engaged in field work over the Arakan Yomas, in western Burma, mention that the eagle has been seen there also.

Now let us return to the bird I had so easily captured. We called her *Kohistani,* which in Persian means mountaineer. I was not at all prepared for the many difficulties and troubles that we had to overcome in training her, and that she was ultimately trained and gave us many happy hours of hunting was made possible only by the inestimable help extended by my father. Single-handed I am sure it would not have been possible for me to achieve much with this particular bird. Even with my father's help it still took almost twice the normal amount of time and labour required for the training of an eagle. Our concentrated efforts and experience had only a very gradual effect in subduing the wild and unpredictable nature of this Himalayan Queen.

To begin with, we found the eagle carried a heavy infestation of mites, which it had probably gathered from the snow pigeons it had been feeding on. And when its mutings were examined under the microscope we found tell-tale traces of tapeworm infestation. In dealing with the external parasites I made my first mistake. When all the old known methods of eliminating the mites had proved unsuccessful, I invoked the assistance of our local veterinary surgeon, who advised me to dust the eagle with Gammexane powder, which is commonly used in this part of the world for ridding poultry of ticks. In spite of the expert advice, as the tin was labelled 'for poultry only' I reduced its strength by mixing it with an equal quantity of wood ash. I hoped in this way to eliminate side effects, and little realised how wrong I could be.

Less than an hour after a liberal application of this mixture of Gammexane and wood ash, Kohistani had a very severe attack of convulsions and threw up all the food she had taken earlier in the day. After these epileptical fits had passed off, the eagle sat up very groggily and I was hoping that the worst was over when she got another attack. This time the trouble lasted much longer and was more intense. She fell off

the perch and got hopelessly entangled in her leash. In trying to rescue her, for I did not want her feathers to be broken, my hand came close to her talons, and she gripped the bare and unprotected palm, sending the main back claw right through it. In her delirium the eagle kept up a spasmodic tightening of her grip, every time sending excruciating pain shooting up my whole arm. It was difficult to say how long I could stand this without fainting, but luckily my father had heard me cry out and rushed to my help. Together we managed to free my hand, which mercifully had started to become somewhat numb.

The swabs of cotton-wool saturated with iodine that I squeezed into the hole in my palm did not put me to any great discomfort, but this anaesthetized feeling unfortunately did not last for long and when the circulation was back to normal I found I had not only a swollen but also a throbbing palm.

During the course of the night I recorded nine such fits. By next morning Kohistani had lost the use of her legs, and remained lying on her breast all the time. The intervals between the fits however gradually grew longer and the next night we registered only three fits. On the third day the eagle was able to sit up for short intervals. During these three days she did not eat anything, and as attempts to force-feed her would induce an attack she was left alone in a warm dark place.

From the third day onwards Kohistani showed signs of improvement. During the day she did not suffer a single attack, and in the evening she ate a little meat, the liver of a hare I had shot in the afternoon. After that she never looked back. But the experience had left her in a state of extreme excitability and great nervousness. Any sudden noise would cause intense agitation and excessive distraction. She refused to cooperate, and would only jump to the fist from a very short distance when pressed by hunger. We could not hope to condition her while she was in this plight, so we decided to feed her up, and refrain from handling her until she was once again in the highest health condition.

Gradually the eagle gained weight, and after some time was back to normal. To all outward appearances, she looked as well as any eagle could, yet she never lost her neurotic jumpiness, and the training was an ordeal for both trainer and trainee. For what seemed an endless number of minutes, you would watch her sitting on the perch with my father standing in front of her, extending a welcoming fist with a little meat. He would beckon and beckon the eagle to jump to the fist, but she would not budge. Kohistani would simply look at all this with a tranquil gaze, and remain so still that you could swear she was a stuffed specimen, and not alive at all.

This went on for almost a month. Then she began to jump with less hesitation and soon she was flying to the fist from a distance of eight to ten feet. These flights were always from the ground, or from the block

perch, and hence from a lower to a higher level. By this time my patience was almost exhausted and I was ready to let the eagle go, but my father kept grinding away at the training as though such resistance was only to be expected from our beauty. It is this quality of being able to withstand resistance for longer than the normal man that makes the difference between a good and a mediocre falconer. It is also a sign of stronger character, and I could see this asserting itself on the eagle. The foundations of her resistance were gradually being sapped and she was beginning to cooperate.

In another few days, I was pleased to see her fly to the fist from the branch of a tree that stood some fifteen feet high. During this period of the training, we were not prepared to take any chances so we used a creance. This meant that if during her short flight from the branch to the fist the eagle decided to quit and turned aside, she would be restrained by the long cord attached to her leash. As soon as she started to come when called from distances beyond eighty feet, the creance became redundant. Once an eagle is flying to the fist without hesitation, whenever called, the creance should not be used. It is very liable to get tangled in a bush or branch, and if a bird under training is suddenly brought up short by the creance it is naturally upset and discouraged from further flight.

Kohistani was now doing very well, and within a few days was in yarak. The time had come to fly her at game. I would here once more like to emphasize that the first flight at game for any newly trained hawk is a very important occasion, for should the first few attempts at catching game be unsuccessful, the hawk loses confidence and is much discouraged.

We chose Kersali, a village nestling under a bluff on the right bank of the Song river at its confluence with the Bandall, for Kohistani's first flight after game. A few paddyfields extended from the village to the steep edge of the tableland lying to the west. Pheasants come from the dense cover on the bluff to feed on the paddy left after harvesting. We arrived very early, before the sun had made its appearance. My father had the eagle on his fist and we had not moved far when I noticed pheasants dodging in and out of the patches of bramble, making for the rising ground ahead. I signalled my father to be ready but it was not necessary, for not only had he seen the birds himself, but the eagle also was keenly following their movements. She bated, and my father let her go immediately, but the wily birds had already sensed danger and scurried back into the nearest bramble-patch. Seeing this, the eagle executed a right-hand sweep and flew to the nearest tree overlooking the bush. She perched on the topmost branch, facing the spot where the pheasants had gone to cover. It was now our business to force the cunning birds out into the open. The pheasants were in a thicket of about a dozen bram-

ble bushes, and were all the while trying to break back, as we tried to drive them towards the eagle. Meanwhile the eagle was becoming restive, her bells tinkling as she constantly shifted her position to get a better view of what was going on below.

Perhaps, after running around so many times in a small circle, the pheasants had lost their sense of direction, or maybe they too had become desperate and had decided to take their chance in the open, eagle or no eagle, when at last the cock bird exploded out of cover with a shrill *chirr* and made for the next lot of brambles. The moment it appeared the eagle shot out like a flash of light and the birds met in mid-air with a reasounding smack.

The eagle came to earth almost at once, gripping the ill-fated pheasant so powerfully that it could not move at all. For a few seconds it squawked pitifully and then was quiet. You could not have found two happier men than Father and I as we stood watching the eagle bother the dead pheasant.

I always found Kohistani very brave, but she would sometimes ignore game no matter how well the stage had been set. I fear my initial blunder of having exposed her to the toxic pesticide was largely responsible for her changing moods. She showed a special fondness for hares, and always bated hard after them if not slipped. I was one day exercising her by letting her follow me, flying from tree to tree. We usually covered a mile or more like this. We were in the middle of our morning jaunt when a hare sprang from almost under my feet, when the eagle was on a tree more than hundred yards behind me. She must also have seen the hare for I heard the tinkle of bells and knew that she had taken off from the tree, and when I turned round she was quite near, flying like smoke. She flew low, hardly three feet above the ground, and the wind escaping through the slits in the bells made a continuous whistle. In the six years the eagle had been with us, I had often before seen what followed next, but the memory of it even today sets the blood throbbing in my temples. The eagle effortlessly grabbed the hare by the nape of the neck, lifted it clean off the ground and raised it over five feet before coming down to earth with both feet firmly planted in the victim. A falconer's dream.

What I wish to stress is not merely the way in which rodents were dealt with, but also the speed at which these birds can fly. Looking at the Mountain Hawk-Eagle one could never imagine how fast it can travel. It is twice the size of an ordinary goshawk and it would be reasonable to surmise that it is slower. On the contrary, I have substantial proof that the Mountain Hawk-Eagle is able to perform just as well if not better than a goshawk, as well as being five times as powerful. The fact that it can capture such fast and nimble prey as parakeets and pigeons is a clear indication that provided it is above the quarry, it can

fly even faster than a goshawk. In manoeuvrability, it is quite its equal.

I had Kohistani with me for slightly more than six years, and during this period she accounted for more than sixty hares apart from other game. She did not always register a kill, and on some occasions the hares got away with a whole skin, but such instances were few compared to the times when hares were bagged. Whenever a hare escaped, I attributed it to the eagle's changing moods, and remembered her ordeal with the Gammexane powder.

I have mentioned the speed at which these birds can move, and the way they can twist and turn when hot on the heels of the quarry. I have had countless opportunities to witness the performance not only of wild mountain hawk-eagles, but also of tame eagles of this species, under controlled conditions that excluded the chance of any error in judgement. Experiments were repeated again and again, and a stop-watch used for timing. Photographic records of the eagle's flight were also made and all confirmed its remarkable speed and manoeuvrability. I have been an ardent falconer ever since my schooldays, and have been lucky enough to handle many hawks, falcons, and eagles. Therefore I have had many opportunities to observe the relative speed of the different birds of prey. My findings are based on personal experience and keen interest.

Barn Owls are often hunted with sparrow-hawks, merlins and other small hawks such as shikras, and I have frequently succeeded in gathering an owl or two with a Peregrine tiercel. But owls are very cunning and can dodge in and out between the branches with exceeding ease. In all cases the hawks and falcons had to stretch themselves to their maximum capacity to catch their prey. One would not have thought the seemingly ungainly Mountain Hawk-eagle able to compete, but I have time and again captured owls both big and small with Kohistani. Amongst the bigger members of the Bubo tribe the Horned Owl was the favourite and the eagle was also very keen on Barn Owls. These screech owls are usually found living by the dozen in a banyan standing isolated from other trees, preferably on the edge of an open field. These stygian creatures love to dwell in such trees, where the thickly overgrown branches give them good protection from enemies during the day. Hollows in the twisting limbs provide excellent tenements for raising a family and it is as difficult to drive the blighters out of this sanctuary as it is to drive a man out of his home. They are always very reluctant to fly, and it takes a lot of shouting and stone-throwing to persuade a novice bird to leave his ancestral abode for the uncertain comfort of the next tree a few hundred yards away.

At such times it was possible to slip the eagle after the retreating owl, and on all such occasions I have witnessed a show magnificent beyond description. The eagle would catch up with the owl in a few determined

wing-strokes and grab it effortlessly. I suppose the mere sight of the monstrous adversary close on their heels made the owls forget how to dodge and swerve. What is surprising is that after the capture of an owl Kohistani always came down to the ground, and did not carry the kill into some tree where it would be difficult for me to get her down. Only when an owl did gain the protection of the next tree, but could not find any convenient hollow to hide in, would the eagle catch it as it sat on the branch. Even then, in nine cases out of ten Kohistani came floating gracefully to the ground with the owl almost hidden in her mighty claws.

As for the bigger owls, *Bubo bubo,* the Great Horned Owl, presented no problem at all. Once it had been located in some ravine its fate was sealed. It never got a chance to get away and its feeble efforts at self-defence were unavailing. There is only one way an owl can outsmart an eagle, and that is if it decides to soar.

Though the Great Horned Owl rarely attempts it, the Turkestan Owl is much given to this sort of escape tactics, and it is great fun to watch these bold fliers hunted by a Saker falcon. Both falcon and owl ascend in what to the observer may appear to be never-ending mounting spirals till they show as mere specks in the azure blue of the sky. Unfortunately for it, the owl is not what may be termed a stayer, and the moment it tires and starts on its downward journey, its fate is sealed. The Saker begins its classic dives and the falconer is rewarded with an astounding series of mid-air strikes. Every time the Saker makes contact with the quarry, feathers explode in the sky as though the owl has been hit by a charge of shotgun pellets.

Towards the close of each hunting season, and just a few days before Kohistani was to be grounded for moulting, I would make it a point to slip her at whatever small game we came across. These last few days of the shikar season always witnessed most intensive hunting, for we bagged all sorts of game, from squirrels, mongoose, and hares, to partridges, bush quail, and neophrons. This was at the start of the hot season, when hunting was possible only during the early morning hours or just before sunset. In spite of the short period at our disposal, we were still able to have an immense amount of sport.

I remember how one day Kohistani killed a mongoose. With a couple of friends, I was out hunting in the morning. The sun was quite warm notwithstanding the early hour—it was hardly 8 a.m.—and we decided to call a few minutes' halt in a mango grove in the shade of the trees that had already started budding. One of my friends was carrying an air-gun and he went ahead to see if he could shoot some bird for Kohistani to be fed upon. Very soon he came charging back to say he had seen a mongoose roving at the far end of the grove. 'Let us try and grab it with the eagle,' I said. But when we reached the spot where my friend had seen the mongoose, we found that it had disappeared. Presuming

it had gone to earth in a nearby warren, we gathered round the hole and were debating what to do next, when all of a sudden the creature poked its head out of the burrow and then shot out as if a posse of devils were after it. I was standing quite close to the hole.

By the time I had unhooded the eagle the mongoose was clear away and was moving at a goodish clip towards the hedge that marked the boundary of the grove. The eagle saw what was happening and hesitated for a fraction of a second, this being her first time at mongoose. Then she launched herself off my fist—I did not cast her after the quarry—and a cheer of exaltation went up from the small crowd as we watched the eagle dodge through the trees and cut out the victim's line of retreat to the boundary hedge. It grabbed its prey with a terrific *woosh* and lifted it clean off the ground. I was horrified to see that Kohistani had gripped her prey by the rump, and that the business end of the protesting quarry was snapping viciously, trying to bite the eagle's hold from its tender behind. Like lightning, the eagle shifted her other foot and firmly nailed the mongoose just behind the ear. All this happened while eagle and quarry were still in the air. After delivering the *coup-de-grace* Kohistani landed not far from where she had first lifted the mongoose from the ground. It was the first mongoose I had ever hunted with Kohistani and I was very happy about her and my achievement.

In dealing with squirrels, she found the going a bit rough. As a matter of fact squirrels are not easy prey even for hawks. The way they can dodge and turn round the branches of a tree would make survival difficult even for a sparrowhawk, if it had to depend solely on catching squirrels for food. During the six years the eagle was with me, however, I managed to get almost a dozen squirrels. A treed squirrel being next to impossible for an eagle to capture, I would try to drive it out into the open by shouting and throwing stones. Meanwhile my father would be waiting, with Kohistani held unhooded and in readiness to be cast off the moment the squirrel touched the ground. There it can never hope to evade an eagle hot on its heels.

Kohistani possessed one unusual quality that enthralled me whenever I witnessed it. Quite unlike some other birds of prey, she never carried game and would always come down to rest on the ground no matter how small the quarry she held in her mighty grip. There was only one exception, when she carried a dead crow up into a tree, but the circumstances were peculiar. One evening, I had gone to a mango garden close to our home with the idea of shooting a crow for Kohistani to eat the next day. I did not have long to wait, for this was a roosting site for crows, and they would come over in huge numbers, cawing, just before dusk. I winged one with the powerful air-gun I was carrying, but unfortunately I had no more pellets with me, and it kept hopping from one branch of the tree to the other, knowing full well that any attempt

to take off would only end in its downfall.

I was thinking of going back for more ammunition when I saw my father approaching with Kohistani. She sat unhooded on my father's fist and was already bating after the wounded crow.

She was unleashed and cast after the crow which was nervously cawing, for it too had seen the eagle. The crow did not have the ghost of a chance, but as Kohistani grabbed it her jess knotted round the twig on which the crow had taken refuge and though she managed to smash loose she flew into another tree some distance away. It had got dark by this time and all we could see was a dark shape moving on the branch where it had alighted and the tinkle of her bells as she shifted her position.

I was under the impression that the eagle was preparing to feather and start eating the crow, but to make sure I dashed home to fetch a powerful torch. When I got back my father told me that the eagle had flown to yet another tree, where the torch's beam showed Kohistani comfortably reposing on a thick branch. There was no trace of the crow, so we had a look in the tree where the eagle had been moving so restlessly and found the crow wedged in the fork of a small branch, ready for Kohistani's breakfast next morning.

We felt sure that she would return to her kill at the first streak of dawn, and feared that, once she had taken her fill, it would be difficult to persuade her to fly to the gloved fist. So we lashed some bamboo poles together, and after some neck-breaking work—for we had to look directly upwards while aiming the long and whipping pole at its target—we managed to topple the dead crow down. Then we left the eagle to sleep in expectation of a marvellous repast the following morning.

Though we came back next day before the sun had risen, we found Kohistani searching the branch where she had stored the crow. When called she flew down obediently to my father's fist, and was perhaps for the first time happy to see us after a night's separation.

On more than one occasion Kohistani followed and robbed other birds of prey of their rightful prize. When the eagle was not taken out hunting she was exercised, and one day, when I had just called her back to fist after letting her follow me, I was about to reward her with a dainty morsel of pigeon meat from my falconer's bag, when a sparrowhawk flew past with a thrush in its claw. This was too great a temptation, and Kohistani immediately took off and with a few sweeping beats of her wings, had caught up with the lesser hawk and claimed her reward. She could have easily killed the sparrowhawk of course but she was on the whole quite kindly disposed towards the weaker birds of prey. I have often left her at home, sitting on the same perch with a Sparrowhawk I had at the time, scarcely a foot apart. And in the presence of other eagles Kohistani behaved very well, maintaining an un-

ruffled, uninterested pose and showing no inclination to fight or quarrel. In one instance, I remember, there was a lot of provocation from another hawk-eagle that would scream, and glare, and try to attack Kohistani. But she would sit quietly on the perch for hours together, while the uncouth hooligan screamed close to her. Her only response to the bad manners of her neighbour was to preen. In spite of her huge size, formidable strength, and undisputed prowess as a killer of game, she was always well-behaved on the perch at home. She was quite indifferent to dogs and did not mind their sniffing at her. She displayed unparalled bravery when required, but otherwise was as gentle as a lamb.

Funnily enough the sight of a bicycle struck terror in her heart. A motorcycle, a truck, or even a railway engine meant nothing to her, but let her see a bicycle and she would start bating. Sometimes she was so much upset that she lost her appetite. If recently fed, she might even throw up her last meal. What could have been the real cause to trigger all this I was unable to know. I tried very hard to find the origin of this strange behaviour.

I had Kohistani for a little over six years, and found that the most difficult period was just after the moulting season had finished, when she was taken from the mews for a refresher course of training. During the moulting season she was fed on a diet of extra fine delicacies, to assist moulting, and naturally she grew very fat. When the moult finished towards the end of September it was quite warm even in Dehra Dun, and the combination of heat, overweight and a long spell of inactivity perhaps accounts for her dislike of being handled. She bated so much that I feared a return of her epileptic fits. To reduce the risk, her diet was gradually reduced towards the end of the moult, and handling postponed until she had lost a few ounces.

She was very choosy so far as her hoods were concerned. For no apparent reason she would take a liking to one particular hood but would not tolerate another of the same size and pattern, and cut from similar leather. I tried many experiments, using the same pattern and leather but different colours, and found that Kohistani never resisted the clamping on of a hood of orange or deep yellow colour. Other colours were never favoured, and if the hood were of a dark brown shade she would start screaming at the mere sight of it.

Kohistani disliked any newcomer to the mews, particularly if it was a child. Perhaps her instinct told her that children's behaviour was unpredictable and that they were not to be trusted. Another curious antipathy was towards brooms.

Keeping a hawk is always uphill work, but one's troubles are amplified when one decides to keep an eagle. The first consideration is naturally how to procure enough food, especially towards and during the moulting season. Hawks can be fed on mutton or beef occasionally,

but this kind of food is not conducive to the growth of healthy feathers and so must be avoided during the moulting period. During moulting, food rich in carotin, and bird or rodent fat, is essential. Collecting doves or pigeons with an air gun did not appeal to me, for at this season birds also are nesting and rearing their young. I always avoided this method of finding fodder for my eagle. Instead I got four pairs of rabbits, and these proved so prolific that in a short time I had more than twenty bunnies running all over the place. I got so fond of those dear little balls of fluff, that I simply could not steel myself to slaughter any one of them. But at the rate they kept multiplying feeding the rabbits became a big problem and soon I was begging people to come and take them as gifts.

One day about this time I noticed mounds of earth freshly thrown up by the gerbille rats that abound in this part of the country, living in colonies of a hundred or more together. The next evening found me carrying four baited rat-traps, which I left in spots where I thought the rats would come out in the night to feed. The idea proved to be a very good one, for early next morning I found all the traps sprung and four worthies stretched out.

Unlike ordinary field rats, gerbilles are not ugly or dirty. All the rats I trapped were very healthy, and extremely clean. In this way I avoided the unnecessary slaughter of birds, and had no longer to bear the burden of supporting a family of rabbits. Every evening the traps were laid and baited, and early next morning I would go and collect the dead rats. They were disembowelled on the spot and carried home to Kohistani. She liked this kind of fare and grew fat on the rodent meat. It was economical for me too, for I no longer had to buy a pigeon every alternative day to feed the eagle. As a matter of fact it made it possible for me to keep two eagles at a time. It only meant laying out more traps, which was no hardship, as there were colonies not far from my home, and my nocturnal nibblings did not seem to have any visible effect on them. Nevertheless I always moved to the next lot of burrows after having trapped in one area for any length of time.

Kohistani always moulted quite well. She started by shedding the primaries as early as March, and moulting would be completed by the third week of September or slightly earlier. During the first year, when the eagle still had a mantle of juvenile feathers, I noticed that these showed a tendency to break off quite often. I followed the usual practice of dipping a dented feather in nearly boiling water. This straightened it out, but unfortunately the feather was extremely brittle after this hot-water treatment, and would snap off whenever the least pressure was applied. When hares or even pheasants were being hunted, the eagle would have a slight struggle to finish the prey off, which would result in one or two feathers breaking or bending. After her first moult, how-

ever, and when she had had a regular diet of rodent meat for a full season, her new feathers were strong, and could be bent without their snapping. From then onwards, no imping or hot-water treatment was ever called for.

All good things must come to an end, and the time came when circumstances beyond my control compelled me to part with Kohistani. I could have given her to a falconer friend in India or Europe, but decided instead to restore her to the free life of the wild.

In preparation, we kept her in the mews after her moult was completed and continued to feed her on rodent meat. We handled her as little as possible, so that after a few weeks she was quite fat and almost wild. Then Father and I took her to a remote area in the Rajaji Sanctuary, where there was plenty of small game for her to feed on, and released her. I don't suppose she remained there long, for it was the mating season. Soon she must have been gripped by a huge restlessness, and have soared up and crossed the Siwaliks to the Himalayas only twenty miles away, to find a mate and raise a family. I often see her in my dreams and hope that, one fine day, I shall see her in reality.

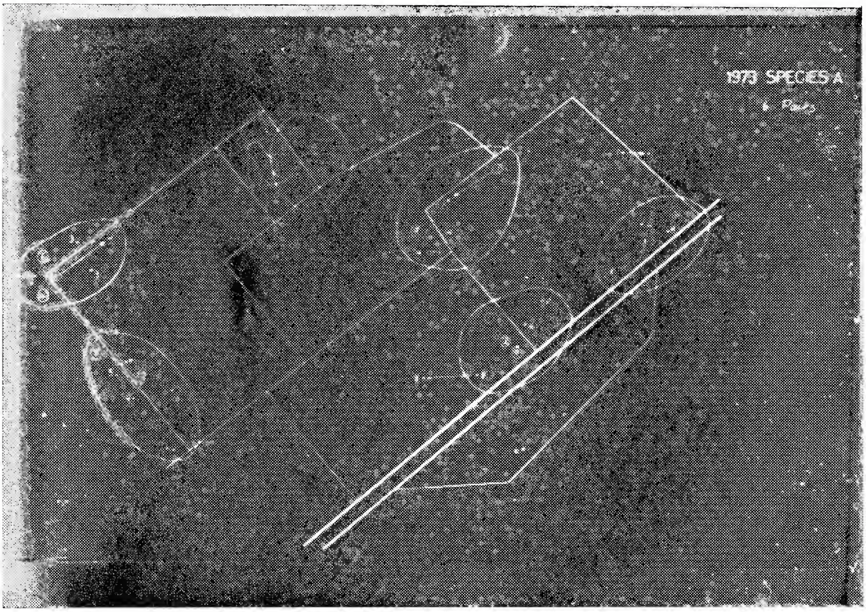

Fig. 1

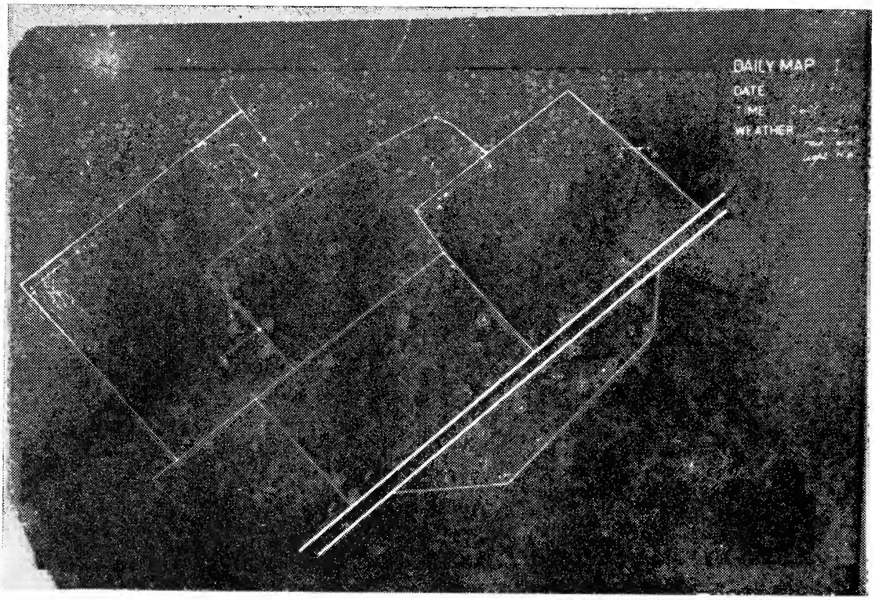

Fig. 2

Fig. 1. Typical visit Map (*see* p. 276); Fig. 2. Species Map (*see* p. 277).

Methods for estimating bird populations[1]

A. J. GASTON[2]

(With a plate & two diagrams)

This paper attempts to describe a number of methods for the estimation of bird populations. The kind of method employed will depend on a variety of factors; the purpose for which the estimate is required, the ecology and behaviour of the species concerned, and the degree of accuracy considered necessary.

In the case of an economically important bird pest, causing direct damage to a standing crop it may be sufficient simply to estimate the damage, and assess the reduction in damage resulting from various control measures tested. An example of this kind of situation would be the use of tape-recordings or shots to scare birds away from orchards. The success of the technique can be assessed directly from the decrease in the percentage of damaged fruit, without knowing how many birds are involved.

In situations requiring some estimates either of the actual number of birds involved, or of relative changes in the size of a particular population, a method must be chosen appropriate to the task in hand. Population estimates, in terms of birds/unit area are generally more difficult to achieve than population indices, which allow comparison between different years, seasons, or areas without giving an idea of the actual number of birds involved.

Where a detailed population study is being carried out it is best to employ both estimates and indices. If a number of populations of the same species are examined, and estimates and indices compared then it may become possible to relate the index figures to the estimates so that actual population figures can be derived from the indices, which usually involve less field-work.

COMPARATIVE INDICES

1) *Line transects.* These are performed by one or more observers walk-

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ing or driving through the area of study, and counting all individual birds seen. The observer's route should be selected prior to the start of the transect, and should, if possible, be random with respect to variations in the habitat, though this is not always possible if pre-existing foot-paths or field borders are followed. When comparing population changes with time over a particular area then the transect, one chosen, should be followed exactly on each subsequent visit. If two different areas are being compared for their relative population densities then transects in the two areas should be equal in length, and an equal length of time should be spent on each.

The length of the transect will depend on the abundance of the bird species being censused. If the area is small then there is no theoretical objection to criss-crossing the same ground, or to counting the same bird twice, provided that this is not done knowingly. A transect of 2-3 miles might be sufficient for counting Bulbuls (*Pycnonotus* spp.) in scrub, whereas a suitable transect for Coursers (*Cursorius* spp.) in the desert might involve a jeep ride of 50 miles.

Line transects are usually used in fairly uniform habitat, or in habitat such as mixed scrub and woodland, where the observer can, on any random route, pass through several patches of each of the constituent vegetational types.

The activity, and hence the visibility, of birds varies with season, weather conditions, and time of day. In order to make successive transects comparable it is important that these factors be taken into consideration. Comparison between different habitats by the transect method is very difficult because birds are unlikely to be equally visible in different types of vegetation. In habitats where the vegetation is dense an auditory transect, made by counting the number of calls heard, rather than the number of birds sighted, may be most useful, but it depends on the species being censused having an unmistakable call. Contact calls and alarm calls are more suitable for this purpose than songs, since singing tends to be seasonal, and usually confined to one sex. The auditory transect is particularly useful in tall woodland where most birds are out of sight in the canopy.

In very open habitats, such as flat desert, or counting sea birds at sea, it is necessary to impose some limit on the distance that birds can be counted from the transect line. At sea a limit of 200 metres is suitable but this has to be estimated by eye, and hence tends to introduce a subjective bias.

An advantage of the transect method is that it is simple to carrry out, and requires no special apparatus. Also, if it is repeated several times over a short period then the resulting figures can be used to calculate a mean and standard deviation, and these give some indication of the reliability of the method.

2) *Tape recordings.* Many birds can readily be attracted to the tape-recorded calls of their own species. A comparative estimate of density can be obtained for these species by using a transect, and playing suitable calls at intervals along the route. Birds attracted to the calls can be counted as they appear, or calls heard in reply can be counted. This method is particularly useful for shy skulking species.

The kind of call employed will depend on the species involved. For most small passerines the song is best, particularly during the breeding season. For birds like Babblers (*Turdoides*), which do not sing, the contact call or the mobbing call can be used. Care must be taken to ensure that the volume at which the call is played remains constant throughout the census, and only observations made at the same time of day, or season can be compared.

3) *Mist netting.* Mist nets (fine nylon nets which trap birds unharmed when they fly into them without seeing them) can be used to assess changes in the abundance of a particular species in a given locality. The number of birds caught depends on many factors; the activity of the birds, the area of nets deployed, the siting of the nets in relation to the vegetation, the amount of time that nets are deployed. Catches made on two days can only be compared if all these factors remained equal.

The effectiveness of mist nets for trapping resident birds declines steadily from the time that they are erected, and if the nets remain in the same sites for several consecutive days local birds learn to avoid them. Ideally there should be sufficient nets available to be able to allow catching 20 or so of the required species within a few hours. Different sites vary widely in the numbers of birds trapped, without any relation to the density of the population, and for this reason it is only permissible to compare catches when nets have been set in exactly the same sites.

This method is probably highly inaccurate, but it can be used in conjunction with population estimates by "capture-recapture" methods. It cannot be used to compare population densities in different habitats, since the structure of the habitat is bound to affect the ease with which birds are trapped. Young birds seem to be more susceptible to trapping with mist nets than older birds, and estimates of populations containing many young birds cannot, therefore, be compared with older populations.

4) *Random nest searching.* An index of the year to year fluctuations in the size of breeding populations of certain species in a particular area can be obtained from the number of nests found annually by random searching, provided that the same amount of time and effort is expended on each year. This makes no allowances for increases in the efficiency of the searcher, and is best suited to species such as Larks and Partridges, where the nest is usually located by flushing the mother bird off the eggs after a systematic beat.

Population estimates

1) **Estimation of breeding populations.** These will be treated under four headings, depending on the kind of social structure involved. It has to be borne in mind that the breeding population in any one season is usually substantially smaller than the total population size. In some species breeding is deferred until they are several years old, and in other species birds potentially old enough to breed may be inhibited by social factors. In the Jungle Babbler (*T. striatus*) only about 30 per cent of the population breeds in one year.

At the same time establishing the size of the breeding population may be important in some cases because it relates directly to the possible rate of increase of the total population.

a) *Colonial nesters.* Birds which breed in large colonies tend to occupy the same nesting area every year, and such colonies are usually well known locally. Storks, herons, cormorants, pelicans, vultures, and flamingos all come into this category. During the non-breeding season birds from a single colony may spread out over thousands of square miles, and because of this it is very difficult to assess the area which is served by a particular colony or to derive an idea of birds' density in terms of pairs/unit area.

Counting nests in a large colony is subject to a number of potential errors. Some birds may make more than one nest if their first effort is robbed by a predator. In some cases previous years' nests persist, and in others nests may be built so close together that it is impossible to tell the boundaries of individual structures. Uncertainty is increased by the fact that in mixed colonies, such as a heronry, several different species may be the owners of such adjacent nests.

The timing of the count is important. If it is too early then some pairs may not have begun to nest, if it is too late in the season then many will have abandoned their nests due to predation or accidents to the eggs. Ideally several counts should be made at different stages in the season. In tree nesting colonies each tree can be tagged with a label stating the number of nests it carries, or the trees can be mapped, and the number of nests in each entered on the map. The total breeding population can then be calculated by summing the maximum counts for each tree.

In a few cases, such as flamingos, or sea-birds nesting on open beaches, it may be possible to count occupied nests from aerial photographs. This is only useful when the colony is known to comprise only a single species, because the identification of species from aerial photographs is probably not possible. For tree nesting birds, such as storks and vultures, this method is not appropriate because nests in the tops of the trees are likely to obscure those lower down.

Photography can also be useful in counting colonies of cliff-nesting species, such as Griffon Vultures (*Gyps fulvus*), and bank nesters, such as Sand Martins (*Riparia riparia*), and Bank Mynas (*Acridotheres ginginianus*). Once the colony has been photographed a blow-up can be used by the observer to tick off nest holes or nests which can be seen to be in use. At old colonies of Bank Mynas, for instance, some holes may not be in use, while others may be occupied by sparrows. A few hours spent observing the colony, and ticking off those holes in use, should be sufficient to estimate the population at that time, but counts should be repeated at intervals throughout the breeding season to allow for early and late nesters.

Weaver colonies are more difficult to count than those of hole-nesters. The nests are quite conspicuous but not all of those built are used. In the case of the Baya (*Ploceus philippinus*) nests are usually suspended in palms or other trees and can be scored for occupation by observing them from a distance. Colonies of Blackthroated Weavers (*P. benghalensis*) in tall grass, or Streaked Weavers (*P. manyar*) in reed beds, are more difficult to watch, and in these cases it is necessary to examine each nest in order to ascertain whether it is occupied.

Small passerine birds, which have a relatively short breeding cycle, may nest several times in the course of a year, and only a proportion of the population may be breeding at any one time. If this is so it may be impossible to get an accurate idea of the size of the breeding population from counting nests at any time during the season. Colonial nesters, however, tend to have their nesting fairly well synchronised. In cases where strongly asynchronous nesting is suspected it may be that assessment of breeding populations gives no real indication of the size of the total population, and the method is then useful only for comparative purposes.

b) *Semi-colonial nesters*. These are species which do not exhibit much overt territorial behaviour, and tend to nest in the general vicinity of others of their own species, but which may on some occasions nest alone. Colonies are not necessarily in the same place from year to year, and are often rather spread out. In some cases the aggregation of nests may be due to the clustering of suitable nest sites, rather than any positive gregariousness on the part of the birds.

Birds in this category include Munias (*Lonchura* spp.), Parakeets (*Psittacula* spp.), and Bee-eaters (*Merops* spp.). The last two of these probably aggregate due to the proximity of suitable nest sites. A big old tree with a number of holes may accommodate several pairs of Parakeets, and sandy bank in otherwise flat country may concentrate the nests of Bee-eaters.

Methods for assessing the size of colonies are the same as for colonial species, but the amount of work required to ensure that all colo-

nies are located is much greater. Watching for concentrations of birds, and searching suitable sites, should be sufficient in open country, but the area that can be covered diminishes rapidly in scrub and woodland.

c) *Territorial species.* This category includes most species of passerine birds, as well as many birds of prey, game birds, waders, pigeons, non-parasitic cuckoos, owls, kingfishers, and woodpeckers. A number of methods for assessing breeding populations of territorial species by mapping sightings of individual birds, and particularly of singing males, have been devised for use in temperature regions. The 'Common Bird Census' method used for its national survey by the British Trust for Ornithology, will be described, and its drawbacks in the Indian situation discussed.

Finding nests for territorial species is usually impractical for a population of more than about 20 pairs. Instead it is easier to map the territorial system of the population, and this has the advantage that, while nesting may be sporadic, territories should remain fairly constant throughout the breeding season.

The British Trust for Ornithology method (hereafter known as the BTO method) is based on surveys carried out at weekly intervals throughout the season by observers on foot. A study area of about 300 acres of farmland, or 100 acres of woodland is chosen, and a base map of the area at the scale of 25″ to the mile prepared, and duplicated.

If the study area is relatively featureless it may be necessary to erect marker posts or paint numbers on the trees in order that the observer can locate himself accurately at any time.

A separate map is used each time that the study area is visited, and this is carried on a clip-board so that observations can be drawn on it easily. The observer follows a route designed to bring him to within about 50 metres of every part of the study area, and each bird sighted in the course of this walk is plotted on the map, using a code of different letters to denote different species, and symbols to denote whether singing or not.

Fig. 1 shows a typical visit map as it appears at the end of one day's visit. Sightings enclosed by circles denote birds seen in song, dots denote individuals not singing, and an arrow connecting two points indicates that the individuals concerned was seen to move from one spot to the other in the BTO census all species are recorded, but the same method could be applied to a few, or only a single species.

A minimum of about 10 visits are made during the season, for each of which a separate map is used. At the end of the season an individual map is prepared for each species by plotting the points for that species from each daily map in turn. Each point is numbered corresponding to the number of the visit, day 1, day 2, etc. An example of the resulting species map is shown in fig. 2.

Fig. 2 depicts a fairly idealised example, and it can be seen that points tend to fall into 6 clearly defined groups, which presumably center on pair territories, with a few scattered observations outside these which can be ignored. This map, therefore, suggests a population of 6 pairs of this species.

The BTO method has been in use in Britain for more than 10 years and its drawbacks are fairly well known. Species which are best censused by this method are those having a short breeding season during which they sing a lot. Birds which like to perch prominently are particularly suitable.

Care should be taken to distinguish unmated males. These usually appear prominently at the beginning of the season, and then later disappear. In some cases they may continue singing long after the other birds have given up.

Birds which present particular difficulties are semi-colonial species, polygamous species, species living in dense vegetation, and species like larks which sing high above the ground, making mapping very difficult. A good practice with singing larks is to watch them until they return to the ground, and then mark that spot.

Species which might be censused by this method in lowland India include those which perch and sing in obvious places, such as the Pied Bushchat (*Saxicola caprata*), Shrikes (*Lanius* spp.), King Crows (*Dicrurus adsimilis*), Rollers (*Coracias benghalensis*), Flycatchers (*Muscicapa* spp.), Robins (*Saxicoloides fulicata*), Magpie Robin (*Copsychus saularis*), and Purple Sunbird (*Nectarinia asiatica*).

Because song is much less important for tropical birds than for their temperate counterparts this method has usually been thought inapplicable in tropical situations, but with some modification it should prove useful. Certain species tend to sing a lot at particular times of day, and particular season, and this should be taken into account. Robins, for instance, sing most vigorously before sunrise, while Wren-Warblers (*Prinia*) sing particularly after rain.

A lot depends on the density of the population being censused. If birds are very dense, then it becomes impossible to distinguish the boundaries of individual territories. If birds are fairly spread out, however, it may be possible to map the territories even without observing song, particularly if the birds are attached to a few look-out posts, as is usually the case with shrikes.

In a few cases this method can be used to assess wintering populations, where these defend territories. This applies to the Black Redstart (*Phoenicurus ochruros*), and the Lesser Whitethroat (*Sylvia curruca*), although it must be borne in mind that in this case the territories are individual, not pair territories.

Two factors may tend to upset population estimates based on the

BTO method; if there is an unequal sex ratio then an assessment based on singing birds (males) may not give an accurate idea of the number of pairs. For some species there is evidence that males outnumber females, and in this case unmated males may inflate the estimate. Also, if there is a large non-breeding, non territory-holding population this may tend to confuse the estimate by obscuring the pattern of territories.

A technique which can be employed in conjunction with a BTO type mapping survey is colour marking with coloured plastic leg-rings, so that birds can be identified individually. This can be used as a check over a small part of the study area to assess the efficiency of straightforward mapping.

Plastic rings are commercially available in England in different sizes and colours, but can also be manufactured out of sheets of coloured plastic, cut into suitable lengths and moulded. Birds should be marked with combinations of different colours. If 10 colours are available this gives a possibility of 100 combinations using two rings in either order (i.e. Red/Green and Green/Red). It is usually advisable to use the same combination on both legs so that the bird can be identified even if only one leg is visible.

This method is best for species which can be readily trapped, such as Robins, Tailor Birds (*Orthotomus sutorius*), or Yellow-eyed Babblers (*Chrysomma sinensis*). Once a suitable number of birds have been marked (about 30-40 at least) then mapping can be carried out as for the BTO census, with the advantage that the territory of a particular individual can be distinguished by known sightings inserted of inferred from the grouping of points.

An advantage of the colour marking method is that it enables non-breeding wanderers to be readily detected. A population containing many of these would result in some colour ringed birds being seen repeatedly (the territory holders), and others never, or seldom being seen again after their marking (the wanderers). From the proportion of those judged to be territory holders to those judged to be wanderers it may be possible to assess the actual size of the non-breeding population, but a snag here is that the trapping method may not be equally effective for both categories. Territory holders are usually less susceptible to catching in mist nets, for instance, than non-territory holders.

The main drawbacks of the colour marking method is that it is very time consuming, and it requires an observer with acute colour vision. It provides much more information about the structure of the population, the size of territories, and the movements of individuals than any other method, however, and is probably the best if a really detailed study of the species' biology is required.

d) *Group territorial species*. These are species in which territories are occupied not by pairs, but by groups of birds, ranging in size from 3-30.

These are fairly easily censused because most of these species are strictly resident throughout the year, and also defend their territories year-round. Because of the variation in the size of flocks these can often be identified individually over small areas by the number of birds that they contain, alternatively some members can be colour marked. The flocks can then be mapped in the same way that their territories are mapped. The winter season is probably the most suitable for counting of flocks, because during the breeding season these have a tendency to fragment during the day. At this season flocks are best counted in the evening when they always join up before flying to roost together.

2) **Sampling methods.** These methods are based on the assessment of the total population by capturing and marking a sample, releasing it, and then taking a second sample in order to find the proportion of marked to unmarked birds. This technique is known 'capture-recapture', or Lincoln Index.

Birds can be marked either with plastic rings, aluminium rings, or with painted or dyed marks on the plumage, or even by clipping the toes. The only limiting criterion for the marking is that it should endure the duration of the study, and that it should not impair the normal activities of the bird.

Once a sample has been marked, and a second sample taken, the total population is calculated from the formula

$$P = S_1 \times S_2/M$$

where P = total population

S_1 = first sample marked and released

S_2 = second sample captured

M = number of marked individuals captured in the second sample

Hence if 30 birds are captured and marked in the first sample (S_1) and 40 captured in S_2, of which 20 are marked, then the total population is estimated by

$$P = 30 \times 40/20$$
$$= 60$$

Theoretically there are several conditions which must apply for this calculation to give an accurate approximation. Both samples should be taken from the population entirely at random (i.e. there should be an equal chance of any individual in the population being captured). The first sample should mix completely with the population after being released, and before the second sample is taken. There should be no immigration into, or emigration from, the population between the two samples.

In practice birds do not usually satisfy any of these requirements. Except in isolated cases, such as land birds on an island, or water-birds in a marsh surrounded by arid country, all bird populations are subject

to continual immigration and emigration at the periphery. Even birds which do not hold territory tend to have a preferred range, and this prevents the population from mixing randomly, and in any case there is no trapping method available that can give an entirely random sample of an entire population.

If this method is to be used, then probably the best trapping technique is to use mist nets, but these should be shifted around in such a way as to ensure even coverage of the entire area, both for the first, and the second samples. Baited wire traps cannot be used for this type of calculation as there are always some individuals which repeatedly enter the traps, while others are trap-shy, and never get caught.

This method may be useful when assessing the size of dense roosting flocks, or the population of skulking species inhabiting dense vegetation. It is unlikely to yield an answer better than 50 per cent accurate.

Successive samples can be treated with more elaborate mathematical

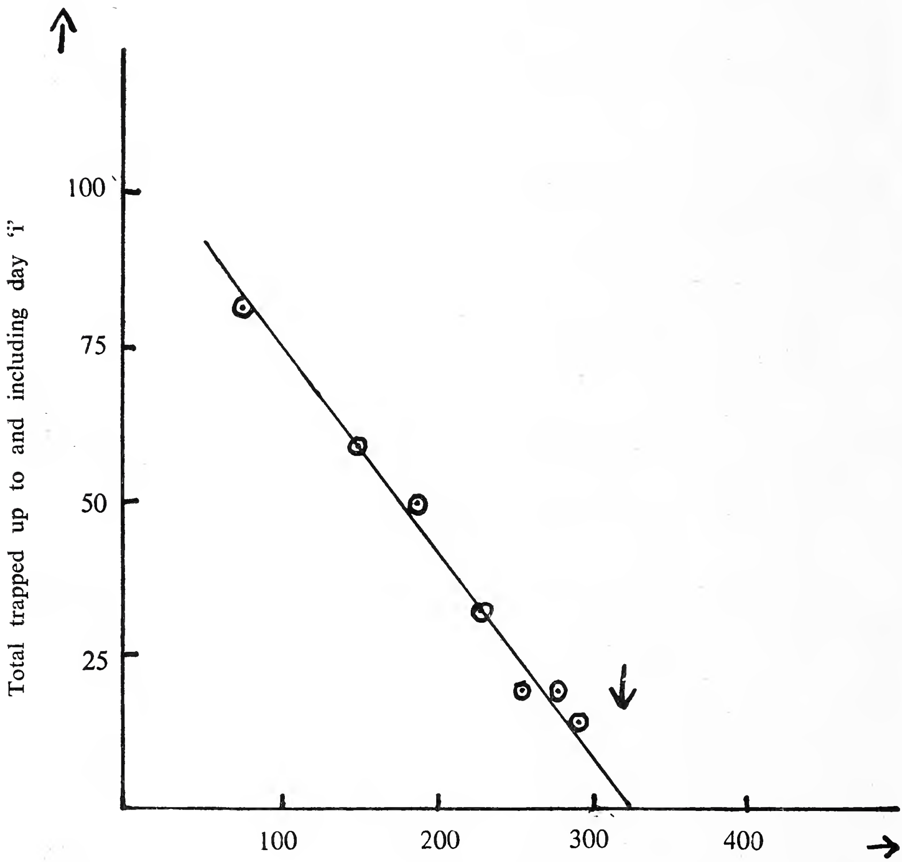

Fig. 1
No. of unringed birds trapped on day 'i'

procedures to yield better estimates but the drawbacks to the method remain the same. These results can also be used in a comparatively simple way, if each successive sample is marked, to yield a population estimate. This is done by plotting the number of unringed birds trapped on any one day against the running total of all birds marked, up to and including that day, on a graph. A sample graph is shown (diagram 1). The x axis shows the total number ringed up to and including day 'i', and the y axis shows the number of unringed birds trapped and ringed on day 'i'. By plotting 3 or more points a line of best fit can be drawn, and extrapolated to meet the x axis. This point (at which no more unringed birds could be caught) gives the total population. This method uses the same assumptions as the capture-recapture method but is easier to calculate for a number of recaptures.

A capture-recapture (Lincoln Index) can also be made using only one day's trapping if the birds are marked in a conspicuous manner. If this is done then, instead of a second trapping, the population can be counted visually for marked and unmarked birds. The resulting calculation is the same as for the usual capture-recapture method, except that in this case S_2 is the number of birds observed on the visual survey, and M is the number of those observed which are marked. A sample calculation, therefore, would be; number of birds captured and marked (S_1) = 50, number seen on a four hour visit to the area the following day (S_2) = 60, of which 15 were marked (M).

Population estimate (P) = $50 \times 60/15 = 200$

3) **Roost counting.** Many species of birds, outside the breeding season, roost in large flocks during the night, scattering to feed during the day, and flighting in to roost about sunset. The size of these roosts can sometimes be estimated by a team of observers counting birds as they arrive at the roost. Most species fly in to the roost in flocks of up to 100 birds and these can be fairly accurately estimated with practice, or in some cases actually counted. At least 4 observers are generally necessary, stationed around the roost, and the sectors covered by each must be clearly defined in order to avoid double counting.

Some water-birds, such as egrets, tend to fly to roost following the line of waterways, and these can be counted by observers sited on these flight lines. Other species which roost communally, and which might be estimated by this method are parakeets, starlings (*Sturnus* spp.), mynas (*Acridotheres* spp.), and crows (*Corvus*).

Roosts can be located by one or more observers moving around by car, and taking compass bearings on the direction taken by flocks flying purposefully just before sunset. Arrows indicating these flight lines can be plotted on a suitable map of the district, and the area at the covergence of the arrows searched on foot to pinpoint the roost. A typical roost-line map is shown (diagram 2).

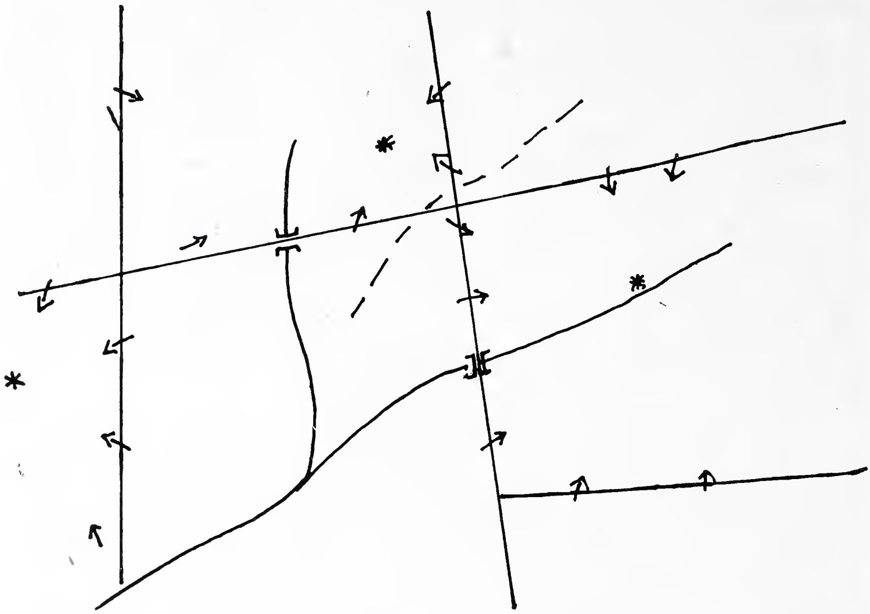

Fig. 2

←Direction of flocks. * Position of roosts. ----- Boundary between feeding areas of 2 roosts.

Only roosts of moderate size (about 100-10,000) can be counted in this way. Larger roosts are more difficult because individual flocks flying in tend to be too large to estimate accurately.

A few species which form much smaller roosts might be censused in this way. In particular peafowl, which roost high up in tall trees might be susceptible to this method. On a moonlight night the birds are quite conspicuous against the sky, and can be easily counted. In areas where tall trees are only found in patches roosts can be located during the day by searching the ground under each group of trees for peafowl droppings, which are readily recognisable.

Very large roosts of small birds such as wagtails (*Motacilla* spp.) or swallows (*Hirundo*), which tend to fly in to the roost in ones and twos, cannot be counted satisfactorily. In this instance an estimate can be obtained by catching birds with mist nets and using the capture-recapture techniques. It has been shown for some species, however, that individual birds tend to return to the same position in the roost every night. If this is true then a capture-recapture estimate will be badly biased.

Roosting is not only a nocturnal phenomenon, gulls and shore birds often form resting flocks at high tide, and these can be counted either

while flighting in or while leaving. Ducks and geese tend to feed at night, and form roosting flocks during the day on open water, which can be counted provided that the stretch of water is not too large. Those ducks which feed mainly on open water such as *Aythya* spp. are particularly easy to count. Dabbling ducks (*Anas* spp.) are more difficult because they tend to prefer marshes and reed beds to open water.

In Britain all major open waters are counted monthly by teams of volunteers, and when coverage is complete this can yield a valuable estimate of the water bird population. The important thing is that all counts should be made simultaneously because ducks are extremely mobile, and counts made at different localities on different days would almost certainly lead to double counting.

Conclusions

Every species of bird, every different habitat requires a technique specially adapted to it. The methods described above are not exhaustive, but provide some indication of the approaches available.

A great deal of work in Britain is being carried out with a view to providing population indices of common birds, and the BTO Common Bird Census is the main outcome of this. Interest mainly centres around the idea that bird populations may provide a sensitive indicator of pollution in terrestrial ecosystems, in the same way that fish can be used as an indicator of river pollution.

Though the kind of amateur participation which can be enlisted in Britain is not available in India it seems likely that a small professional team could provide the same kind of information over limited but representative areas. This kind of work could help to assess the impact of new agricultural techniques, particularly the massive application of fertilisers and pesticides, on bird populations in rural areas. This in turn could furnish evidence, and "early warning" about potentially disastrous changes in the ecosystem.

Ecology of Indian Desert; IV – Photoperiods in relation to growth behaviour of two desert species of *Sida*[1]

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Varying photoperiods appeared to influence the growth patterns of two desert species of *Sida*. The photoperiod observed for the optimum growth in both the species was 12 hours. However, when compared among themselves, the fresh weight, dry matter accumulation and moisture content in *S. spinosa* were found to be always more than in *S. grewioides*. Flowering was first initiated in 9 and 12 hours photoperiodic exposures in *S. grewioides* and *S. spinosa*, respectively. *Sida grewioides* indicated a preference for longer photoperiod as the seedlings did not survive in less than 9 hours exposures, although in longer ones beyond 12 hours the plants remained only in vegetative state. In *S. spinosa* plants did not die even in 3 hours photoperiodic exposures in the 24 hours cycle, but remained in vegetative state like those in longer photoperiods of 18 and 24 hours.

Introduction

In the recent past voluminous information has been accumulated on the relation between growth behaviour and photoperiods in a number of plant species. The photosynthetic process in green plants which takes place in light masks the respiratory activity, since in the latter process, the products are broken down, which are produced in the former. The different photoperiods definitely affect the production and growth of new leaves resulting either in a well developed shoot system or a poor one, this in turn affects the productivity. The translocation of extra photosynthetic products to the root affects the growth and morphology of root system. Garner & Allard (1920) stress the importance of the length of the daily light periods as a factor influencing the growth and development of plants. Root growth and its subsequent development has always been recognised as important phenomenon.

[1] Accepted March 1972.

Light energy is one of the important factors affecting a large number of known and unknown biochemico-physiological processes as well as plant size and shape. In many plants the length of the daily photoperiods also regulate the meristematic activities (Kadam-Zahavi & Alvarez-Vega 1968). Flowering is primarily an ecological phenomenon, yet comparatively very little study of the flowering process has been made from purely ecological standpoint (Salisbury 1963). The photoperiods and temperature may act at any of the several stages in the ecological life cycle of any plant species. Several reviews on the physiology of flowering are available. Lang (1952) initiated the series covering photoperiodism and vernalization; whereas Liverman (1955), Doorenbos & Wellensiek (1959) and Salisbury (1961) emphasised the importance of mainly photoperiodism and plant growth.

Photosynthetic process is of paramount importance with respect to physiological adaptation of the species to the environment. Ketellaper (1965) has shown that dry matter production of tomato and soybean plant responds to variations in the length of the light-dark cycle. It has been earlier proposed that unfavourable cycles are injurious to plant growth (Ketellaper 1960; Tukey & Ketellaper 1963).

Light as the energy source is of primary importance which brings about the most striking changes as compared to other environmental factors. Information on the effects of photoperiods on the root and shoot growth, dry matter production, floral initiation and fruit setting in arid zone plants is extremely meagre. Floral initiation in long day plant and short day plant is determined by a floral stimulus, which is generated in the leaves under the influence of photoproduction and is then translocated to the growing points (Lang 1952). It is generally assumed that scarcity of water leads to the poor development of root and shoot system, but it also leads to early flowering and ultimately fruit setting which is based solely on field observations. To test this assumption, experiments were conducted on varying photoperiods in relation to two desert species of *Sida*.

Experimental methods

Five days old seedlings of *S. grewioides* and *S. spinosa* were transplanted in 12 cm wide earthen pots. One seedling per pot was maintained till the experiments were over. The soil in the pots was kept moist by regular watering and they were placed in shade in the beginning to ensure better seedling growth and establishment. After 10 days these experimental pots were exposed to various photoperiods viz., 3, 6, 9, 12 and 18 in the 24 hour cycle and also in continuous light. The extra light duration besides sunlight was supplied by six flourescent tubelights of

40 watts each from a distance of one meter. One set of plants was kept in total darkness. These experiments were started from 8th August 1969 and the observations were made up to 60 days (8th October 1969). During this period the durations of day and night periods were approximately equal. Three replicates of each set were used for the present study. The observations have been made for growth behaviour of root and shoot, fresh weights, dry matter accumulations, moisture contents, flowering and fruit settings. The temperature during the day remained 32° $\pm$ 2°C and in the night 24° $\pm$ 2°C.

Observations

(a) *Root and shoot growth*

The growth of the two *Sida* species in the experimental pots remained comparatively poor from those growing in nature, which may be due to edaphic factors. The growth analysis in different photoperiods has been given in tables 1 and 2.

Table 1

Growth performance of *S. grewioides* in different photoperiods after 30 and 60 days of treatment. All measurements are in mm.

Photoperiods in 24 hr cycle	Days	Main shoot length	Main root length	Length of longest lateral root	No. of axillary branches	Total No. of leaves per plant
3 hours	30	80	100	60	—	14
	60	—	—	—	—	—
6 hours	30	120	150	130	—	25
	60	—	—	—	—	—
9 hours	30	220	200	200	5	52
	60	253	310	330	9	98
12 hours	30	220	220	220	8	65
	60	320	480	360	11	113
18 hours	30	180	220	120	—	33
	60	240	310	220	—	54
24 hours	30	140	200	120	—	24
	60	180	240	180	—	44

It would be evident from table 1 that the root system was poorly developed in 3 hours photoperiodic exposures in both the plant species. The number and length of laterals were less when compared with plants in other photoperiodic exposures. *S. grewioides* could not survive in 3 and 6 hours photoperiodic exposures till the end of the experimental period. The growth of the root system was increasingly favoured with

the increase in photoperiodic exposures up to its optimum period of 12 hours in both the species studied. However, the photoperiod beyond 12 hours exposure appeared to inhibit the growth of the root system. The best growth of root system in both the species was found in 12 hours photoperiods (Tables 1 and 2). Further increase in the photoperiodic exposures did not favour the growth of root system. When compared among themselves, the root system of *S. spinosa* was more extensive and better as compared to that of *S. grewioides.*

Similar to the root system, the shoot system was also poorly developed in 3 hours photoperiod (Tables 1 and 2). The shoot growth was progressively better with the increasing photoperiodic exposures. The best shoot growth in *S. grewioides* as well as in *S. spinosa* was observed in 12 hours photoperiodic exposures, which was similar to root system. In 12 hours optimum photoperiods these plant species exhibited maximum shoot branches and leaves.

TABLE 2

GROWTH PERFORMANCE OF *S. spinosa* IN DIFFERENT PHOTOPERIODS AFTER 30 AND 60 DAYS OF TREATMENT. ALL MEASUREMENTS ARE IN MM.

Photoperiods in 24 hr cycle	Days	Main shoot length	Main root length	Length of longest lateral root	No. of axillary branches	Total No. of leaves per plant
3 hours	30	180	180	81	—	10
	60	250	200	100	—	22
6 hours	30	370	320	260	18	94
	60	460	380	300	24	205
9 hours	30	400	400	300	20	110
	60	520	460	340	28	254
12 hours	30	550	450	400	26	163
	60	700	550	480	32	318
18 hours	30	380	330	290	8	72
	60	510	480	450	20	147
24 hours	30	290	230	275	4	57
	60	350	410	380	9	88

With respect to longitudinal growth, the data indicated that the length of photoperiods has a qualitative influence on both the species. Under relatively short photoperiods the plants remained stunted *S. grewioides* could not survive for 60 days under short photoperiods of 3 and 6 hours. Under longer photoperiods elongation of the main axis as well as lateral branches occured. Photoperiods longer than the optimum were found to be inhibiting shoot growth. However, *S. spinosa* expressed better growth performance when compared with *S. grewioides.*

TABLE 3

EFFECT OF DIFFERENT PHOTOPERIODS ON FRESH WEIGHT, DRY MATTER ACCUMULATION AND MOISTURE CONTENT IN ROOT AND SHOOT OF *S. grewioides* AFTER 30 AND 60 DAYS OF TREATMENT. ALL VALUES ARE IN GRAMMES

Photoperiods in 24 hr cycle	Days	Root			Shoot		
		Fresh wt.	Dry matter	Moisture content	Fresh wt.	Dry matter	Moisture content
3 hours	30	0.050	0.035	0.015	0.350	0.050	0.300
	60	—	—	—	—	—	—
6 hours	30	0.120	0.050	0.070	1.020	0.180	0.840
	60	—	—	—	—	—	—
9 hours	30	0.640	0.250	0.390	3.620	0.900	2.720
	60	3.300	0.870	2.430	10.400	2.920	7.480
12 hours	30	0.890	0.330	0.560	3.970	0.920	3.050
	60	3.500	0.940	2.560	10.800	3.070	7.730
18 hours	30	0.240	0.108	0.132	1.800	0.350	1.450
	60	0.840	0.190	0.650	2.500	0.490	2.010
24 hours	30	0.230	0.105	0.125	1.400	0.260	1.140
	60	0.520	0.150	0.370	2.000	0.320	1.680

TABLE 4

EFFECT OF DIFFERENT PHOTOPERIODS ON FRESH WEIGHT, DRY MATTER ACCUMULATION AND MOISTURE CONTENT IN ROOT AND SHOOT OF *S. spinosa* AFTER 30 AND 60 DAYS OF TREATMENT. ALL VALUES ARE IN GRAMMES

Photoperiods in 24 hr cycle	Days	Root			Shoot		
		Fresh wt.	Dry matter	Moisture content	Fresh wt.	Dry matter	Moisture content
3 hours	30	0.070	0.050	0.020	0.740	0.120	0.620
	60	0.170	0.080	0.090	1.500	0.740	0.760
6 hours	30	0.440	0.210	0.230	4.110	0.950	3.160
	60	2.250	0.520	1.730	6.900	2.520	4.380
9 hours	30	1.140	0.510	0.630	5.940	1.620	4.320
	60	2.500	0.730	1.770	8.600	3.370	5.230
12 hours	30	1.920	1.020	0.900	11.250	3.250	8.000
	60	8.790	2.290	6.500	13.800	6.950	6.850
18 hours	30	1.400	0.410	0.990	5.620	1.870	3.750
	60	4.290	1.450	2.840	12.100	6.500	5.600
24 hours	30	0.500	0.230	0.270	4.090	1.020	3.070
	60	1.590	0.390	1.200	6.300	1.920	4.380

(b) *Fresh weight, dry matter accumulation and moisture content*

The experimental plants died after a few days when placed in continuous darkness. The experimental plants of *S. grewioides* under 3 and 6 hours photoperiodic exposures could not survive up to the end of 60 days. The effect of different photoperiods on fresh weights, dry matter accumulations and moisture contents of root and shoot in *S. grewioides* and *S. spinosa* are given in tables 3 and 4.

It would be evident from table 3 that the maximum fresh weight in roots, 0.890 g and 3.500 g in *S. grewioides;* and 1.900 g and 8.790 g in *S. spinosa* in 30 and 60 days respectively, were found in both the species when exposed to 12 hours photoperiods. The maximum fresh weights of shoots in *S. grewioides* were 3.970 g and 10.800 g at the end of 30 and 60 days, respectively. The maximum fresh weights in *S. spinosa* were 11.250 g and 13.800 g at the end of 30 and 60 days, respectively. The fresh weight, dry matter and moisture contents of roots as well as shoots in both the species increased with the increasing photoperiodic exposures till 12 hours of the optimum. Further increase in photoperiodic exposures caused a decline in the fresh weights, dry matter accumulations and moisture contents.

(c) *Flowering and fruiting*

(i) *S. grewioides* — The effect of various photoperiods on flowering and fruiting status of this species at different intervals of time has been studied and expressed in table 5.

TABLE 5

THE FLOWERING AND FRUITING STATUS OF *S. grewioides* AT THE END OF 15, 30, 45 AND 60 DAYS AFTER THE PLANTS WERE EXPOSED TO DIFFERENT PHOTOPERIODS IN A 24 HOURS CYCLE.

No. of	Photoperiods in 24 hours Cycle					
days	3	6	9	12	18	24
15	—	—	fl	—	—	—
30	—	—	fr	fp	—	—
45	+	+	fr	fl	—	—
60	+	+	fr	fr	—	—

— = vegetative; + = plant did not survive; fp = floral primordia; fl = flowering; fr = fruiting.

It would be evident from table 5 that floral initiation in *S. grewioides* is controlled by 9 and 12 hours photoperiods. The first initiation of flowering could be observed as early as after 10 days in 9 hours and after 25-30 days in 12 hours photoperiodic exposures. The plants in other photoperiods remained vegetative.

Plants kept in total darkness did not survive and died within the period of 10 days of starting the experiment. The plants in 3 and 6 hours photoperiods died after 30 and 45 days, respectively. However, the plants under 18 and 24 hours photoperiods remained completely in vegetative state. The earliest fruit setting could be observed only in 12 hours photoperiods during the experimental period.

(ii) *S. spinosa* — The bud initiation to certain extent appeared to be apparently independent of photoperiods, but the formation of complete floral buds and flush of flowering in this species depended on the light exposures of definite periods. The flowering and fruiting status of the plants was estimated when the plants had already received the described photoperiods at the end of 15, 30, 45 and 60 days. The periodic observations for the above mentioned plant species have been tabulated in table 6.

TABLE 6

THE FLOWERING AND FRUITING STATUS OF *S. spinosa* AT THE END OF 15, 30, 45 AND 60 DAYS AFTER THE PLANTS WERE EXPOSED TO DIFFERENT PHOTOPERIODS IN A 24 HOURS CYCLE.

No. of	Photoperiods in a 24 hours cycle					
days	3	6	9	12	18	24
15	—	—	—	fp	—	—
30	—	fp	fl	fr	—	—
45	—	fl	fr	fr	—	—
60	—	fr	fr	fr	—	—

— = vegetative; fp = floral primordia; fl = flowering; fr = fruiting.

It is evident from table 6 that the first floral initiation was observed in 12 hours photoperiods as early as after 7 days of the start of the experiment. After 15 days additional floral initiation were observed in plants exposed to 9 hours photoperiods. Further initiation of flowering was seen later in plants exposed to 6 hours photoperiods. The plants kept in total darkness did not survive and died within 15 days of the start of the experiment. However, no floral initiation could be visualised in plants exposed to 3, 18 hours photoperiods and continuous light. Besides flowering, the first fruit setting was also observed in plants exposed to 6, 9 and 12 hours photoperiods during the experimental period.

DISCUSSION

Information on the effects of photoperiods on the plants of desert

environment is extremely meagre. Hardly any plant species of arid region of India has been classified as to its photoperiodic requirements. *Sida grewioides* and *S. spinosa* appear to be influenced by day lengths. The photoperiods definitely affected the production and growth of new leaves and the magnitude of growth of roots and shoots. The leaves of the plants are perceptors of the radiant energy. The photoperiodic treatment of the leaves causes the photosynthetic apparatus to stimulate there. This photosynthetic apparatus starts different physiological and biochemical processes in the chlorophyllous organs of the plant.

Ketellaper (1965) showed that variations in the length of light-dark cycle affect the growth behaviour and dry matter production of tomato and soybean. Sharma & Sen (1971) observed that the growth behaviour and dry matter production in *Solanum nigrum* was changed with the different photofractions. Austin (1948) reported that in *Impatiens balsamina* fresh and dry weights of the aerial and subterranean parts were maximum under the 16 hours photoperiods. Root development was proportionally greater under longer photoperiods. The percentage of moisture contents in aerial system was greater under the longer photoperiods. Chawan (1970) has observed that various photoperiods definitely affected the growth behaviour of roots in *Corchorus aestuans* and the short photoperiods were unfavourable for the growth. It has been earlier proposed that unfavourable photofractions are injurious to plant growth (Ketellaper 1960; Tukey & Ketellaper 1963).

Wareing (1956) showed that there is a relation between the length of the optimal light period and the duration of dark period. The initiation of flower buds and their further development has been connected with the auxin production. Chawan & Sen (1971) showed that day length influence the bud initiation, the flush of flowering and specially the fruit setting in *Corchorus aestuans*. The morphological changes in the vegetative parts of shoot and the development of yellow-red pigments appeared to be connected with fruit setting in *C. aestuans*. Halaban (1968) stated that flowering response of *Coleus frederici* and *C. blumei* is dependent on the photoperiods. Both these plant species have a critical day length of about 12 hours. Photoperiodic effects on floral initiation in a wide variety of plants have been thoroughly reviewed in recent years (Chouard 1960; Lockhart 1961; Salisbury 1963).

The growth behaviour, flowering and fruit setting in the two species of *Sida* have been studied from purely ecological standpoint in this study. Short photoperiodic exposures were found to be unfavourable for the plants. Certain photoperiodic exposures were the direct requirements for flower initiation and fruit setting. This may be interpreted as (a) complete absence of floral initiation in plants exposed to certain photoperiods, (b) change in the growth behaviour of root and shoot system, (c) plants not getting sufficient daily photoperiodic exposures

remained vegetative for a long time, when in contrast to those getting the required photoperiods flowered and showed fruit setting in the experimental duration of 60 days.

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Observations on the reproductive Biology and early postnatal development of the Panther, *Panthera pardus* L., in captivity[1]

J. H. Desai[2]

(*With three text-figures*)

Introduction

Among the big cats, the panther is the most widely distributed species over the world (Walker 1964). Like the tiger it has been subjected to an increasing hunting pressure and persecution from the last century. In the recent past it has declined noticeably in peninsular India and is mostly found in certain favourable localities such as sanctuaries and is almost rare in many places where it was common formerly (Krishnan 1972). Considerable information regarding its habits, habitat and hunting technique is available from the records of hunters and naturalists, but little is known of its breeding habits in the wild.

Considering the secretiveness of the panther it is little wonder that such information is notably lacking in literature. However, in view of its importance as one of the major predators, a knowledge of the reproductive biology is essential background information. This study was undertaken to provide information (1) on the reproductive behaviour of the panther; (2) to ascertain the duration of oestrus, breeding season, gestation period and size of litter; and (3) to provide comparative data on the early postnatal development of the panther. This paper is based on data collected at the Delhi Zoological Park from 1958 to 1973 and on comparative records available from various other zoos.

Materials and methods

The Delhi Zoological Park was officially opened to the public on

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[1] Accepted June 1973.

[2] Joint Director, Delhi Zoological Park, New Delhi-3.

1st November 1959 but work on the zoo had started in 1955. In 1956 the zoo received four panther cubs as presents from different sources. The Delhi zoo was successful in breeding panthers for the first time in 1960, when a litter of two cubs was born on 29th May. Until May 1973, 63 panther cubs had been born to nine pantheresses.

The panthers at the Delhi Zoological Park are kept in spacious enclosures which provide sufficient room for exercise. Each enclosure has small cells at the back where the panthers are shut in during the night. The floors of the cells are cemented but wooden platforms are provided as warm resting places.

The panthers are fed six days in a week on buffalo calf meat and on Friday of each week no food is given. On average, an adult panther is given 5 kg of fresh raw meat with bones daily, but the quantity is adjusted according to the size, age and general condition of the animal.

For the purpose of this study, data have been drawn from my own observations from 1963 onward, supported by the records maintained at the Delhi Zoological Park in the form of individual animal history cards, daily observation reports and Head Animal Keepers' registers.

The measurements of seven newly born cubs were recorded within twelve hours after their birth. The early postnatal growth of one cub was recorded from the time of birth till the age of four months, when it had weaned completely; and that of other two cubs till the age of two months. All the three cubs were raised by their respective mothers.

Comparative data on early postnatal development of the cubs were derived from Zurich zoo (Weillenmann 1963); New York zoo (Crandall 1964) and Sao Paulo zoo, Brazil (Carvalho 1968).

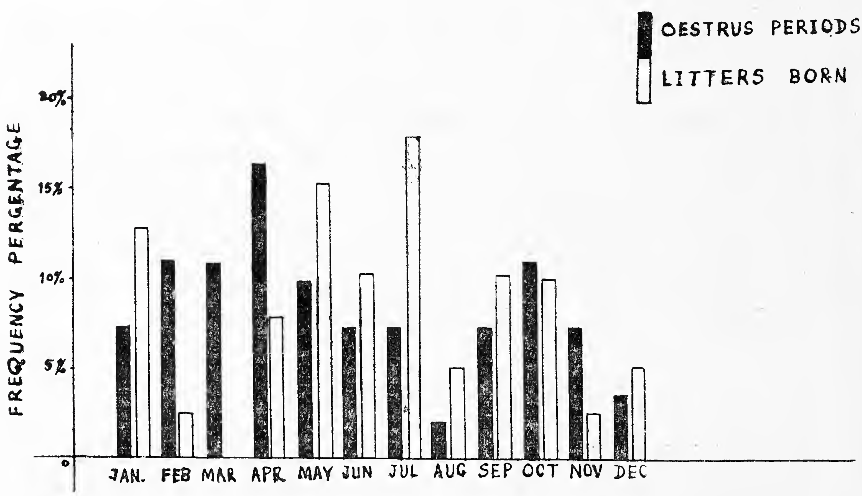

Fig. 1. Frequency distribution of oestrus periods and birth of Panther cubs.

Breeding season

Panthers breed all the year round (Prater 1971). Between the years 1828 and 1961, panthers had bred during all seasons at Whipsnade and Regent's Park (Jarvis & Morris 1962). It has been stated that in India panther cubs are born between February and March (Blandford 1888-91).

At the Delhi Zoological Park the females come in oestrus during all the months of the year (Fig. 1). From 1958 to 1973, 55 oestrus or heat-periods of nine females have been recorded, during which these females were mated several times by the males and from 1960 to 1972, 63 cubs were born in 39 litters. These data are presented in Table 1.

Table 1

Breeding season of Panther, *Panthera pardus*, in captivity

Months	Number of oestrus or heat-periods	Percentage	No. of litters born		Percentage
January	4	7.3	5	(8)	12.8
February	6	10.9	1	(2)	2.5
March	6	10.9	–	–	—
April	9	16.4	3	(5)	7.7
May	5	9.9	6	(9)	15.4
June	4	7.3	4	(4)	10.3
July	4	7.3	7	(12)	17.9
August	1	1.8	2	(3)	5.1
September	4	7.3	4	(7)	10.3
October	6	10.9	4	(7)	10.3
November	4	7.3	1	(3)	2.5
December	2	3.6	2	(3)	5.1
Total	55	100	39	(63)	100

Figures in bracket indicate number of cubs.

Duration of oestrus

Behaviour such as willingness to be stroked by their keepers, increased rubbing on bars and walls of the cages, repeated rolling over on the back indicate that the female is in oestrus (Sadlier 1966). The duration of oestrus was taken as the total number of days on which the above behaviour of a female was recorded and when she permitted mounting and copulation by the males.

Available data on the oestrus periods of 9 adult pantheresses show a wide range of variation (Table 2).

TABLE 2

BREEDING BIOLOGY OF PANTHER, *Panthera pardus*, AT DELHI ZOOLOGICAL PARK

Specimen	No. of oestrus periods	Range of oestrus (days)	Average oestrus period (days)	Average of last day of oestrus to birth (days) (gestation period)	Average number of cubs/litter
Budhi	9	6 – 12	9	92.2 (5)	1.6 (6)
Tara	7	4 – 10	7.4	94.6 (3)	1.7 (4)
Heer	3	5 – 10	5.0	91.0 (2)	1.7 (4)
Rani	4	7 – 13	7.5	91.0 (3)	1.6 (5)
Vimla	6	6 – 12	8.5	93.6 (3)	1.6 (5)
Ganga	3	8 – 11	10.0	93.0 (2)	1.0 (2)
Kali	7	6 – 12	8.1	—	—
Meenu	9	7 – 12	8.0	93.0 (5)	1.6 (11)
Jamuna	7	8 – 14	10.0	87.5 (2)	1.5 (2)

Figures in brackets indicate number of litters.

SEXUAL MATURITY

Mivart (1881) reports that the domestic cat becomes reproductively mature at the age of one year. The Scottish wild cat breeds first when about 12 months old (Mathews 1941). Sankhala (1967) states that tiger cubs mature at an age between $3\frac{1}{2}$ and 6 years. Young female lions become cyclic at the age of about 3 years, while males appear to require several months longer to achieve sexual maturity (Crandall 1964).

One pantheress (Tara) came into oestrus for the first time at the age of 1 year and 8 months at the Delhi Zoological Park. Another pantheress (Ganga) became cyclic at the age of 2 years 11 months and Heer and Jamuna did so at the age of 3 years 2 months and 3 years 3 months respectively. Two females Meenu and Rani littered for the first time at the age of 2 years 3 months and 2 years 9 months respectively (Table 3). One male Ajay mated for the first time at the age of 2 years.

TABLE 3

OBSERVATIONS ON SEXUAL MATURITY OF PANTHER, *Panthera pardus*, AT DELHI ZOOLOGICAL PARK

Specimen	Date of birth	Date of first oestrus	Age at which observed in oestrus for the first time	Date on which first litter was born	Age at which littered for the first time
Tara	20.8.56	5.4.58	1 – 8	5.8.60	4 – 0
Ganga	15.4.63	5.3.66	2 – 11	15.6.66	3 – 2
Heer	March 56	24.5.59	3 – 2	29.5.60	4 – 2
Jamuna	15.4.63	3.7.66	3 – 3	–	–
Meenu	27.4.58	Records not available		11.7.60	2 – 3
Rani	Oct. 58	Records not available		18.7.61	2 – 9
Budhi	24.5.57	10.3.61	3 – 10	18.6.61	4 – 1

Mating behaviour

Properly adjusted and well-mated pairs of panthers breed freely in captivity but attempts to introduce mature specimens to each other are not without risks of injury (Crandall 1964). When any female comes in oestrus at the Delhi Zoological Park, a male is put in the adjoining cage from where the two can see and smell each other. If both show signs of compatibility, it is assumed that they will accept each other and subsequently both are introduced to each other in a large enclosure. They approach each other very cautiously. The muscles of both animals remain taut and they continually growl and snarl at each other. After some time they relax and gradually come closer, till they are face to face. They sniff each other. When mutual confidence is established, the female starts rolling on her back in front of the male and presents herself. She sits with her forelimbs extended fully on the ground, her hind limbs remaining half bent. The male approaches from behind and mounts, and his first insertion takes place within 4 to 8 seconds. Actual coition time varies from 10 to 50 seconds. During coition, the animals emit a variety of guttural sounds. As the climax of the act approaches, the male firmly holds the skin of the female's nape between his incisors and both panthers make a high-pitched sound. As soon as copulation is complete, the male dismounts quickly or is thrown off. Sometimes a short scuffle takes place. After each copulation the female lies flat on the ground for some time. After a short interval, the female again approaches the male, and the whole process is repeated.

During the peak of oestrus copulation takes place 5 to 60 times between 8.00 a.m. and 5.00 p.m. At this time the male and female are both unconcerned about any other activity and show no interest even in the food offered to them.

As stated earlier, bringing male and female together in zoos is not without risk. Sometimes the partners behave aggressively and one of them may be seriously injured or even killed by the other. In June 1967, one of the females Rani was introduced to a male Milu. For some time they behaved very well, but suddenly the male, which was heavier and bigger, caught hold of the female, and a serious fight took place. Rani died of injuries two days later.

Gestation period

The gestation period of the panther is given as 90 to 100 days or 98 to 105 days by Kenneth (1953). Asdell (1946) records it as being 92 to 95 days and Pocock (1939) notes a gestation period of 102 days for an African leopard at Whipsnade Park Zoo as being exceptional. Cran-

dall (1964) gives one gestation length for a black leopard as 90 days from the middle of the heat period. Sadlier (1966) notes 100 day gestation period for two litters of the Chinese leopard from the second day of oestrus. The longest gestation period of the species is recorded as 112 days, at Prague zoo (Dobroruka 1968). Prater (1971) gives the gestation period as 13 weeks. It is difficult to compare the above data as in most cases the date of conception is defined differently. For purposes of this study, the duration of gestation is estimated as the period from last day of mating to birth, and the mean period was 91.9 days, the extremes being 84 and 98 (Table 2).

Litter size

Prater (1971) records that two to four cubs are usually produced. Dobroruka (1968) states that over a period of 15 years at Prague zoo, three young have been born on only two occasions. One was born in two instances and two in seven instances. Jobaert (1960) mentions that in the Congo leopards give birth to two or three young. Zuckermann (1953) records one to three young per litter in the Zoological Gardens of London from 1839 to 1937. According to Pushp Kumar (Curator, Nehru Zoological Park, Hyderabad), usually one to two cubs have been born in a litter at the Nehru Zoological Park, three cubs have only been born on two occasions (pers. comm.).

Data on 39 litters at the Delhi Zoological Park indicate that two cubs per litter were born on twenty occasions, one on seventeen occasions and only in two instances were three young born. The average was 1.6 cubs per litter (Table 2).

Postnatal development of the young

The panther cubs born in the New York and Zurich zoo weighed 0.567 kg and 0.430 kg at birth respectively as recorded by Crandall (1964) and Weillenmann (1963).

The weights and measurements of seven cubs at Delhi Zoological Park indicate that a newly born cub weighs approximately 0.500 kg to 1.00 kg and measures 360 mm to 483 mm from tip of nose to tip of tail between pegs (Table 4). All cubs were born with their eyes closed.

TABLE 4

MEASUREMENTS OF CUBS OF *Panthera pardus*, RECORDED WITHIN TWELVE HOURS AFTER BIRTH

Date of birth	Sex	Weight in kg	Total length in mm	Tail length in mm	Ear length in mm	Forefoot in mm
29.1.66	Male	1.000	483	181	25	103
25.6.66	Male	0.750	360	130	—	75
29.9.66	Female	0.575	420	133	15	95
29.9.66	Female	0.600	430	165	15	102
24.4.67	Female	0.500	360	120	11	80
10.6.67	Female	0.600	370	140	15	90
20.6.67	Male	0.950	432	163	24	108
Average		0.710	407.8	147	15.8	93.2

At birth the panther cub is a helpless little creature as its eyes are closed and the movements of the limbs are uncoordinated and rather random. The skin on nose-tip, paws and perineal area is mostly pink. The fur is short, the spots are faintly developed and the whiskers are black in colour. A cub emits a low cry when hungry or uncomfortable.

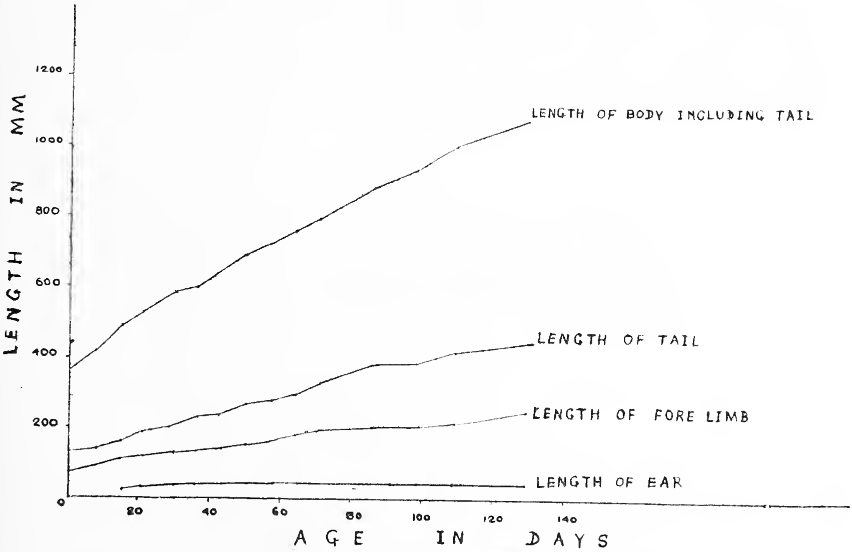

Fig. 2. Growth rate of body parts of cub born at Delhi Zoo (Table 5).

A panther cub born in 15th January 1966 was measured and weighed from birth till the age of 129 days when it was completely weaned and handling was no longer possible. Details of the measurements are given in table 5.

TABLE 5

GROWTH IN WEIGHT AND LENGTH OF PANTHER, *Panthera pardus*, BORN AT DELHI ZOOLOGICAL PARK

Age in days	Weight in kg	Total length in mm	Length of tail in mm	Length of forelimb in mm	Length of ear in mm
0	0.750	360	130	75	—
8	1.000	420	140	90	—
15	1.250	490	160	110	30
21	1.450	530	190	120	35
29	1.550	580	200	130	40
36	1.800	600	230	135	40
43	2.150	640	240	145	43
50	2.400	700	270	155	45
57	2.800	725	280	160	50
64	3.050	760	300	185	50
71	3.250	800	330	200	50
86	4.000	890	390	210	50
98	4.750	940	390	210	50
114	5.600	1010	420	220	50
129	6.250	1080	450	255	50

In Fig. 3, the growth rates of panther cubs hand-reared at Zurich and New York zoos are compared with those of young cubs reared by their mothers at Delhi Zoological Park and Sao Paulo Zoo, Brazil. Further details of the physical development and tooth eruption of panther cubs at Delhi Zoological Park, Sao Paulo Zoo, Brazil and New York Zoo, USA are given in Table 6.

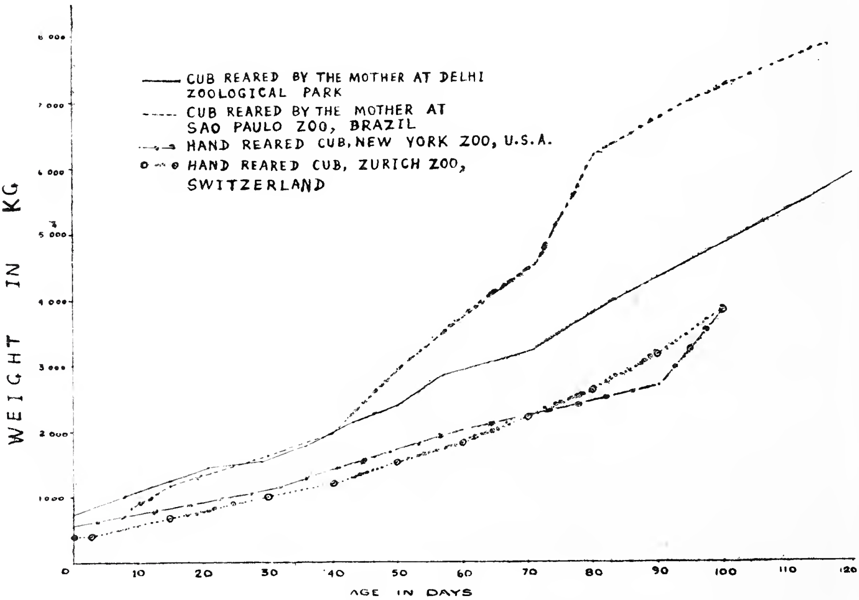

Fig. 3. Growth rate of cubs born at Delhi zoo compared with cubs in other zoos.

TABLE 6

COMPARISON OF PHYSICAL DEVELOPMENT OF PANTHER CUBS BORN AT DELHI ZOOLOGICAL PARK AND OTHER ZOOS

Specimen	Age in days when: eyes open	incisors erupt	1st canine erupts	1st molar erupts	weaned	permanent canine erupts
Born at Sao Paulo Zoo Brazil on 18.7.1966	9	20	—	45	120-125	280
Born at New York Zoo, U.S.A. on 23.2.45	6	—	—	—	—	—
Born at Delhi Zoological Park (India) on 15.6.1966	8	21-29	29	52	114-129	—
Born at Delhi Zoological Park on 29.9.1966	4	22	30	53	—	—

DISCUSSION AND CONCLUSIONS

Figure 1 shows that the panther breeds throughout the year and cubs are produced during all seasons in captivity. However, there is a peak period of births during the months of January, May and July, while February and November show a low percentage of births. During March not a single cub was born at Delhi Zoological Park between 1958 and 1973. This corresponds to the low breeding activities during December. According to the records of Whipsnade and Regent's Park from 1828 to 1961, the maximum number of births took place during the months of March, August and October while minimum births took place during January. The records of San Francisco zoo, USA, from 1929 to March 1967, show a high percentage of births during April and May and a low percentage during November, December, February and March (Reuther & Doherty 1968). The breeding records of panthers at Jaipur zoo indicate that from 1954 to 1963 not a single cub was born during the months of February and November (Sankhala & Desai 1969).

The records of San Francisco zoo and Jaipur zoo compare well with those of the Delhi Zoological Park. The variations in peak periods of

birth may be due to the different climatic conditions and local conditions.

2. All the larger felidae appear polyoestrus in captivity (Eckstein & Zuckermann 1956). Several authors (Asdell 1946; Eckstein & Zuckermann 1956; Sadlier 1966) give seven days as the duration of the oestrus period in lionesses. Sankhala (1967) states that the mating period of the tiger ranges from 3 to 23 days. Sadlier's data (1966) of three female panthers of three different types show mean length of oestrus for the species as 6.7 days.

The duration of oestrus varies from 4 to 14 days, according to the data of nine females at Delhi Zoological Park. There is also a wide range of individual variation among the pantheresses as shown in Table 2. It is not known whether age, physical condition, climate and frequency of copulation are responsible for such variations. The mean length of oestrus calculated from 55 oestrus periods of nine females is 8.1 days.

3. There is much individual variation in the age at which panthers attain sexual maturity. It appears that panthers become sexually mature at an age of between 2 and 4 years. However, no definite conclusion can be drawn from this small sample.

4. Well-adjusted pairs of panthers breed freely in captivity, but the first meeting involves risks of fatal injury. The mating behaviour of panthers is very similar to that of the tiger described by Sankhala (1967). The entire act of copulation lasts from one to three minutes but the actual coition takes only ten to fifty seconds. Mating takes place any time during the day. Panthers may mate five to sixty times in a day.

5. Data on 39 litters born at the Delhi Zoological Park from 1960 indicate a gestation period of 84 to 98 days with an average gestation of 91·9 days. This compares well with the gestation periods given by several authors (Asdell 1946; Kenneth 1953; Crandall 1964 and Prater 1971).

6. The ratio of number of cubs per litter shows that usually one or two cubs are born at a time in captivity. A litter of three cubs is born only occasionally. The average of 39 litters is 1·6 cubs per litter.

7. A newly-born panther weighs on an average 0.710 kg and measures 408 mm (Table 4). Its eyes are closed at birth and open any time from four to nine days later. It has no co-ordination of movements and cannot walk properly or stand upright. During the first four weeks it requires extreme care and nursing by the mother. Infant mortality occurs mostly during the first four weeks. The incisors are cut at the age of 21 to 29 days and the canines erupt at the age of 30 days. It starts licking and biting solid food when it is 52 days old and the first molar is cut. At the age of about 70 days, it starts taking buffalo calf meat or goat meat in captivity. In the beginning, nursing is frequent but the period of suckling at each feeding is reduced. As the cub grows, the fre-

quency of nursing is reduced but the period of suckling at each feeding increases. At the age of 70 days, it suckles only two to three times in a day. It is completely weaned at 114 to 130 days. The growth rate of the cubs reared by their mothers is much better than that of hand-reared cubs. This is evident from the data of cubs reared by their mothers at Delhi Zoological Park and Sao Paulo zoo, Brazil as compared to the hand-reared cubs of New York and Zurich zoos (Fig. 2).

There is much individual temperamental variation. Some mothers take good care of their cubs, others neglect them and some pantheresses even eat their own cubs. Cannibalism although not common, is prevalent among panthers even in well-managed zoos and needs further investigation. As a rule all pantheresses are very possessive and protective of their cubs and become very ferocious if they sense any danger to them.

The panther is one of our most magnificent and graceful animals. It is well adapted for survival in highly variable climates and habitats. Its short gestation period and reproductive potential suggest that under normal conditions it can maintain itself. However, with large-scale destruction of habitat due to industrialization and agriculture, depletion of its prey and indiscriminate poaching, it has a slender chance of survival in the wild. In order to evolve suitable measures for its protection further scientific study of the species in its natural habitat is desirable.

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Plant-pest status of root-eating ant, *Dorylus orientalis*, with notes on taxonomy, distribution and habits (Insecta : Hymenoptera)[1]

M. L. Roonwal[2]

(With three text-figures)

Introduction

The history of the economic status of the large root-cutting ant, *Dorylus orientalis* Westwood (Hymenoptera: Formicidae: Dorylinae), in the Indian Region has been curiously controversial. The very first record of it as a plant-pest (potatoes) by Barlow (1899) was immediately disputed by Forel (1899) who then, and also later (1923), maintained that the species is exclusively insectivorous. Subsequently, several entomologists recorded it as attacking various plants in India, Sri Lanka and Burma, but Mukerji (1934) again asserted that it is exclusively carnivorous (eating insects and earthworms) and refused vegetable food. Like several other earlier observers, I have personally seen this ant seriously attacking potato tubers, in Dehra Dun, but here again we have the following denial (*in litt.*, 3 November 1971) from so authoritative a source as the Director, Central Potato Research Institute, Simla:

"We have no recorded reference about these ants as pests of potatoes or about the control measures against them."

In view of this confusion and controversy, I have in the present paper examined briefly, from the available records and from personal observations, the economic status of this ant as a pest of plants, and also added some notes on its control, taxonomic status, geographical distribution, habits and biology.

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Status as Plant-pest, and Control

Status as plant-pest. In view of the controversy as stated above, I have given below a summary of the available records regarding the attacks of this ant on plants.

1. Barlow (1899).—Damages potatoes (but *see* Forel 1899).

2. Forel (1899, 1923).—(i) (1899, p. 198): Doubts Barlow's (1899) record of damaging potatoes; says it eats only insects. (ii) (1923, p. 17): Doubts its herbivorous nature and considers it as entirely carnivorous.

3. Green (1903, p. 39).—Sri Lanka: Its workers live entirely underground and are confirmed vegetarians. It's a serious pest of potatoes, making galleries in tubers. Also attacks tubers of dhalias and roots of sunflower (*Helianthus* sp.); in later case eating off tender bark below collar.

4. Stebbing (1905, p. 683; 1908, p. 73).—India (Calcutta): Attacks potatoes and "cornflour plants".

5. Lefroy (1906-09): India and Sri Lanka: (i) (1906, pp. 231-232): Attacks healthy living plants, e.g., cauliflowers, cabbages, artichokes, etc., just below soil and completely destroys them. (ii) (1907, p. 128): Damages vegetable crops. Sporadic local pest of vegetable gardens. (iii) (1909, p. 238): Attacks plants, eating them below or at soil-level. Workers also attack workers of the harvest ant, *Pheidole indica.*

6. Dutt (1912, p. 247).—Pusa (Bihar): Damages vegetable crops but not seriously.

7. Rutherford (1914).—Sri Lanka: Attacks kohl-rabi.

8. Fletcher (1914-20).—(i) (1914, p. 274): South India: Attacks growing plants including young coconut palms. Ceylon: Perforates pods of groundnut and consumes contents; also attacks its roots. Attacks sugarcane. (ii) (1917, p. 281): India (Bihar): Regularly attacks cauliflower seedlings below ground. (iii) (1920, p. 35): India (Bihar and Uttar Pradesh): Attacks underground parts of vegetables (potatoes, cauliflower, etc.) and early-sown groundnuts. Ceylon: Attacks roots of potatoes and other vegetables.

9. [Burma] (1918, p. 52).—Burma: Attacks sugarcane setts.

10. Speyer (1918).—Sri Lanka: Attacks vegetables.

11. Hutson (1919-39).—Sri Lanka: (i) (1919, pp. 276-77): Bores in potatoes. (ii) (1920): A pest of potatoes. (iii) (1933a): Attacks carrots, onions and *Arachis* sp. (iv) (1933b, pp. 276-279:) Workers attack underground portions of several vegetables and also some young trees, e.g., citrus. Attack chiefly in May-September. (v) (1936, pp. 293-295): Attacks vegetables, shrubs and trees. (vi) (1937): Attacks ginger rhizomes. (vii) (1939): Severely attacks coconut seedlings; also attacks potato tubers and roots of tree-tomato (*Cyphomandra betacea*).

12. Mukerji (1934).—India (Calcutta): Workers are not vegetarians; seen feeding on live beetle grubs and live earthworms (reared on them in the laboratory); did not eat vegetable food offered.

13. Ghosh (1936, 1940): (i) (1936, pp. 23-24): India: Attacks bee-hives and eats larvae and pupae [attack is presumably by winged males]. (ii) (1940, pp. 130, 138, 141): Burma: Attacks seedlings of trees, cutting roots and killing plants; also attacks potato tubers and seedlings of coconut palms.

14. Beeson (1941; reprint 1961, p. 386).—India and Sri Lanka: "Appears to be entirely herbivorous", and is occasionally a pest in gardens (particularly of vegetables) and in seed-beds in nurseries; bulbs and tubers are hollowed out.

15. Cherian and Ramachandran (1943).—India: Occasionally attacks bee-

hives for honey and pollen, and also destroys bees and brood.

16. Wilson (1964, pp. 442-443).—Sri Lanka: Workers found underground in disturbed forests and cultivated land.

17. Pruthi (1969, p. 466).—India: Attacks plants; is also carnivorous.

18. Unpublished records.—(i) Forest Research Institute, Dehra Dun: (a) West Bengal (Batasi, 1830 m. Darjeeling District): Attacking oak, *Quercus lamellosa.* (b) Assam: Jiri Forest, Cachar: Found in decaying climber. (ii) Mr. P. L. Chaturvedi, U.P. Institute of Agricultural Sciences, Kanpur (*in litt.*, 28 August 1971): Attacks potato tubers especially in early stages of growth; also vegetable seedlings of cauliflowers, cabbages, etc. (iii) Director, Central Potato Research Institute, Simla (*in litt.*, 3 November 1971): *Not* known to attack potatoes (*sic*!). (iv) Present authoı: Serious pest of potato tubers in Dehra Dun (February and April).

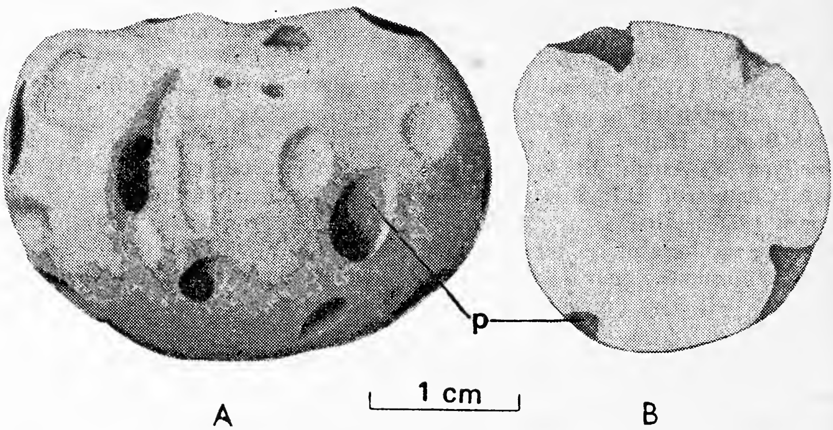
It will thus be seen that in India, Burma and Sri Lanka *Dorylus orientalis* is a plant-pest, sometimes a serious one, of several plants including vegetables, tubers, bulbs, shrubs, trees and also including cash crops such as sugarcane, coconut palm, citrus and groundnut. Tubers of potatoes and bulbs are eaten through hollow (see Figs. A and B, potato), while in other cases the roots and root-collars, especially of seedlings in gardens and nurseries, are eaten. The damage is entirely underground and is done by the workers. (Workers, it should be noted, are not entirely herbivorous; they also eat insects and earthworms, *vide infra,* Habits.).

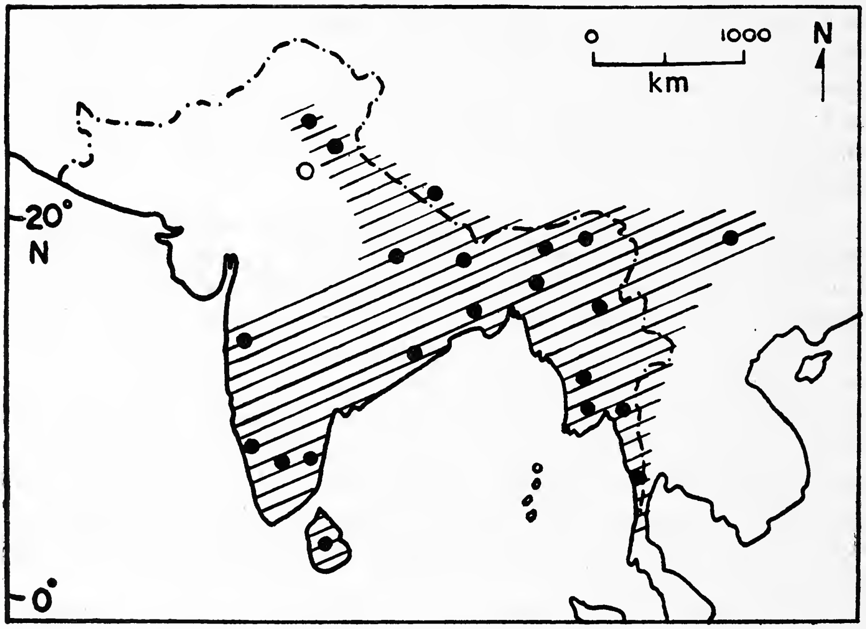
Control. The following is a summary of the available information on control. The ant is entirely a soil pest, doing its damage underground. Control methods must, therefore, be based on treatment of the soil with insecticides and fumigants. The earlier workers (Lefroy, Fletcher, Hutson, Ghosh) recommended the following treatments which they found to be effective:- (i) Add small quantities of crude oil emulsion or kerosene oil emulsion to the irrigation water. (ii) Fumigate soil with petrol before planting (1-2 pints to 30 sq ft), by pouring in small holes and then plugging them. (iii) Before planting, treat a few inches of surface soil with wood-dust or ashes soaked in carbolic acid and diluted with water. (iv) Treat soil with the fumigant paradichlorobenzene at 1 oz to 1 sq yard of soil.

P. L. Chaturvedi (Entomologist, U.P., Kanpur, *in litt.*, 28 August 1971) recommends soil treatment by the following insecticides:- (a) 3 litres of 30 per cent emulsifiable concentrate (E.C.) of aldrin in 1,000 litres of water. Spray this quantity in root region per acre of potato crop. (b) Heptachlor (2 % E.C.). (c) Gamma benzene hexachloride (B.H.C.) (20% E.C., based on lindane). Both to be used as above.

Taxonomic Status and Distribution

Taxonomic status. The synonymies and the more important taxonomic references are given below:





C

Dorylus orientalis Westwood

FIGS. (A) and (B): Potato tubers showing damage caused by the workers. Dehra Dun. (A) In surface view. (B) In cross-section. FIG. (C): Map of Indian Region and neighbouring areas, showing the approximate geographical distribution (shaded in diagonal lines). Solid circles indicate the major localities where the species has been found.

p., pits excavated by the workers.

Dorylus (Alaopone) orientalis Westwood 1835

1835. *Dorylus orientalis* Westwood, *Proc. zool. Soc. Lond.*, London, *3*, p. 72. "India Orientali".

1840. *Typhlopone curtisi* Shuckard, *Ann. Mag. nat. Hist.*, London, 5, p. 265. Worker.

1840. *Dorylus longicornis* Shuckard, *Ann. Mag. nat. Hist.*, London, *5*, pp. 321-322. Bengal.

1881. *Alaopone oberthueri* Emery, *Ann. Mus. Stor. nat. Genova,* Genoa, *16,* p. 274. Worker. Calcutta.

1889. *Dorylus fuscus* Emery, *Ann. Mus. Stor. nat. Genova,* Genoa, *27,* p. 487. Worker. Rangoon, Burma.

1901. *Dorylus orientalis* Westw. (and *D. curtisi* Sh., *fuscus* Em. and *longicornis* Sh.), Forel, *J. Bombay nat. Hist. Soc.,* Bombay, *13*(3), pp. 462-464. Revision.

1903. *Dorylus orientalis.* Westw., *D.o. fusca* Em. and *D.o. longicornis* Sh., Bingham, *Fauna Brit. India, Hymenoptera,* London, *2,* pp. 3-5.

1964. *Dorylus* (*Alaopone*) *orientalis* Westw., Wilson, *Pacific Insects,* Honolulu, *6*(3), pp. 442-443. Revision.

Field diagnosis

Male (winged): Length of head and body 17-25 mm; of forewing 16-18 mm. Brownish yellow, head dark reddish brown.

Female: Unknown.

Worker: Without wings and eyes. Head and body castaneous brown. Antennae with 9-11 segments (Wilson 9, Sri Lanka, Forel 11). Abdomen elongate, flattened dorsally and thus without a distinct waist. Of two forms, major and minor. Total length: Major 5-11 mm, minor 2.5-3 mm.

Illustrations

The illustrations available in the literature are: (1) Emery (1881, p. 274): Worker, head and antenna, *A. oberthueri.* (2) Bingham (1903, p. 5): Good figure of a ♂ and a worker major. (3) Stebbing (1905, p. 683; and 1908, Pl. XXIII): Figure of a ♂ and a worker (the latter wrongly labelled as ♀). Lefroy (1906, p. 232): Good figure of a worker. This is repeated by several authors, e.g., Lefroy (1907, p. 128), Dutt (1912, p. 247) and Ghosh (1936, p. 24; 1940, p. 130).

Geographical distribution. In addition to the records of Forel (1901), Wilson (1964) and others, I have examined examples from the following Indian localities in the collection of the Forest Research Institute, Dehra Dun:- (i) Bernag, 1830 m alt. (Almora District, Uttar Pradesh). (ii) Batasi, *c.* 1830 m alt. (Darjeeling District, West Bengal), *ex "Quercus lamellosa"*. (iii) Jiri Forest (Cachar, Assam), *ex "decaying climber"*. The following are the detailed locality records, countrywise:-

(1) INDIA: *Uttar Pradesh*: Dehra Dun, 610 m.; Berenag (Almora Dist.), 1830 m.; "Siwaliks". *Bihar*: Pusa. *Orissa*: "Orissa". *West Bengal*: Calcutta and vicinity (Calcutta, Sibpur, Barrackpore); Darjeeling; Batasi, *c.* 1830 m.2 (Darjeeling Dist.). *Assam*: Jiri Forest (Cachar

[Silchar] Dist.); Nambour Reserve (Sibsagar Dist.). *Maharashtra*: Poona. *Karnataka*: "Kanara". *Tamil Nadu*: Madras; Coonoor. (2) NEPAL: Amlekhganj, 520 m. (3) BURMA: Tenasserim; Rangoon; Pegu; Moulmein; Bhamo; Kowkareet; Palon; Carin Cheba; Kabo, 120 m. (4) SRI LANKA: Kandy, 600-700 m. (5) CHINA: Meitan, Kweichow (southern China).

On this basis the approximate geographical distribution may be summarised thus: India (whole, except the extreme northern and north-western parts); southern Nepal; Sri Lanka; Burma (south to Tenasserim); east to southern China (Kweichow) (Fig. C). Going up to about 1830 m altitude above sea-level.

HABITS AND BIOLOGY

Swarming

Males swarm at night and are attracted to light (females are unknown). In north India they swarm at the end of the cold weather, in late February (Lefroy 1909). But swarming in April also occurs at Dehra Dun (note in Ledger Files in Entomology Branch, Forest Research Institute, Dehra Dun; extract given below):

> About 820 examples [presumably winged males] emerged in a 10 × 20 feet outdoor cage in New Forest, Dehra Dun, on 10 April 1928. Cage erected in March 1926, and planted with roots and cuttings of teak in June 1926. Possibly at that time a pair (or more) of this ant was introduced in the cage with the soil adhering to the roots. If so, the time between egg-laying and swarming of next brood is about two years. It is hardly likely that the species got entry into the cage through a tunnel from outside; no swarming occurred in the neighbouring cages or in the vicinity.

Season of damage

The season when the workers cause damage seems to vary with climate. In Dehra Dun I observed them attacking the potato crop in early February and again in April. In Sri Lanka, the attack is chiefly in May and September (Hutson 1933b).

Food habits etc.

Workers have the termite-like habit of living entirely underground and making tunnels and galleries through the soil to reach the plant parts. They are largely vegetarian, eating tubers, bulbs, rhizomes, roots and other underground parts of plants. They also eat animal food such as insects and earthworms, but it is not known whether this is habitual or occasional. In the laboratory, Mukerji (1934) reared workers exclusively on beetle grubs and earthworms; they refused plant food. They also occasionally eat larvae and pupae of bees, as well as pollen and honey from bee-hives (Ghosh 1936; Cherian & Ramachandran 1943).

Sometimes they are also known to attack the workers of the harvest ant, *Pheidole indica,* which are carried to the nest where they are killed and cut into pieces (Lefroy 1909). Males are probably carnivorous but no exact information is available.

The nest is made underground rather deep in the soil but little else is known about it.

It will thus be seen that our knowledge of the habits and biology of this ant is very limited and there is scope for considerable work.

Acknowledgements

I am grateful to the following persons for supplying useful information and for other assistance: K. S. Pradhan, Zoological Survey of India, Calcutta; P. K. Sen-Sarma and the staff of the Entomology Branch, Forest Research Institute, Dehra Dun; P. L. Chaturvedi, Entomologist, U.P. Institute of Agricultural Sciences, Kanpur; and the Director, Central Potato Research Institute, Simla.

Summary

1. In view of the controversy about the status of the ant *Dorylus orientalis* as a plant-pest (some authors maintaining that it is exclusively carnivorous), all the available information has been re-examined and fresh observations added.

2. It is established that in India, Burma and Sri Lanka the ant (in the worker stage) is a definite, sometimes serious, pest, attacking the underground portions of several plants including economic ones such as vegetables, potatoes, groundnuts, coconut seedlings, citrus and sugarcane setts.

3. Information on its taxonomic status is summarised. There are four synonyms: *D. curtisi* (Shuckard), *D. fuscus* Emery, *D. longicornis* (Shuckard) and *D. oberthueri* (Emery).

4. The geographical distribution is, India (whole, except N and NW parts), S. Nepal, Sri Lanka; Burma and S. China (Kweichow).

5. Notes on habits and swarming are given.

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Sacred groves of India—A plea for continued conservation[1]

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(*With a plate*)

Introduction

The practice of nature conservation is a very ancient tradition in India, so ancient in fact, that its roots go back to the pre-agricultural, hunting gathering stage of the society. The protection accorded to many plant and animal species such as the Peepal and Umber trees and the Langur and Nilgai is well known. There are also instances of entire biological communities such as all aquatic creatures in a rock-pool or all plant life in a patch of forest receiving protection because of their association with some deity. With the weakening of religious beliefs these creatures and communities are now in danger of losing this traditional protection. We are writing this to make a plea that we must not lose our legacies from these ancient practices, but must make every effort to incorporate them in an enlightened approach to nature conservation.

Sacred groves are one of the most valuable of such legacies from the primitive practices of nature conservation. Scattered, presumably throughout India, are tracts of sacred forests which have been completely or nearly completely immune from human interference on grounds of religious beliefs. The nature of religious cults associated with such sacred groves suggests that the practices are very ancient, deriving from the hunting-gathering stages of the society. The composition of the vegetation, corresponding to the climax formation for that region, corroborates the supposition that the sacred groves have been immune from human interference for a very long period of time. These sacred groves may range in size from a clump of trees to as much as twenty hectares in area. Even the smaller groves often harbour some old and

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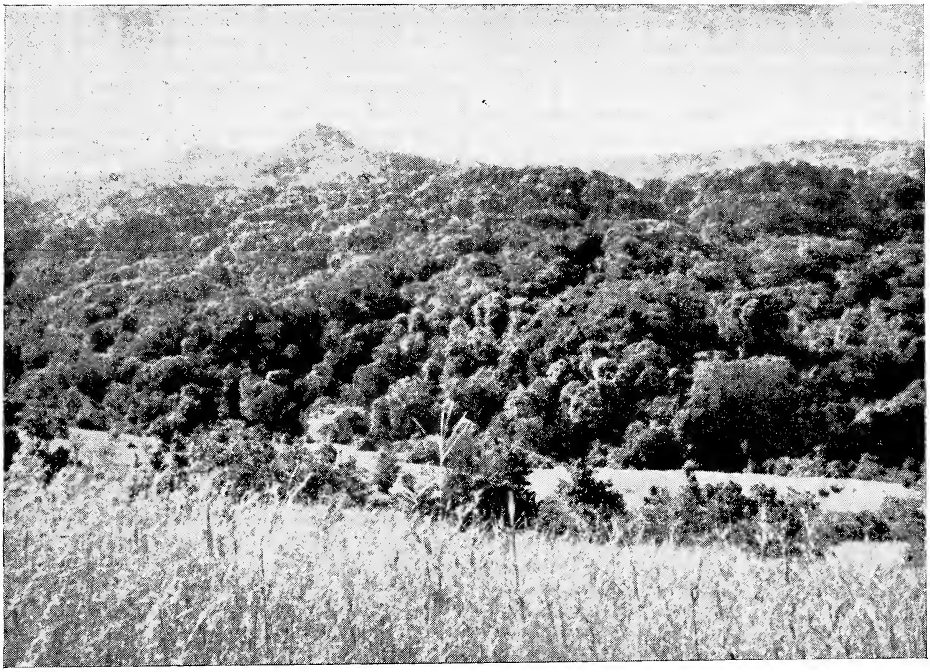

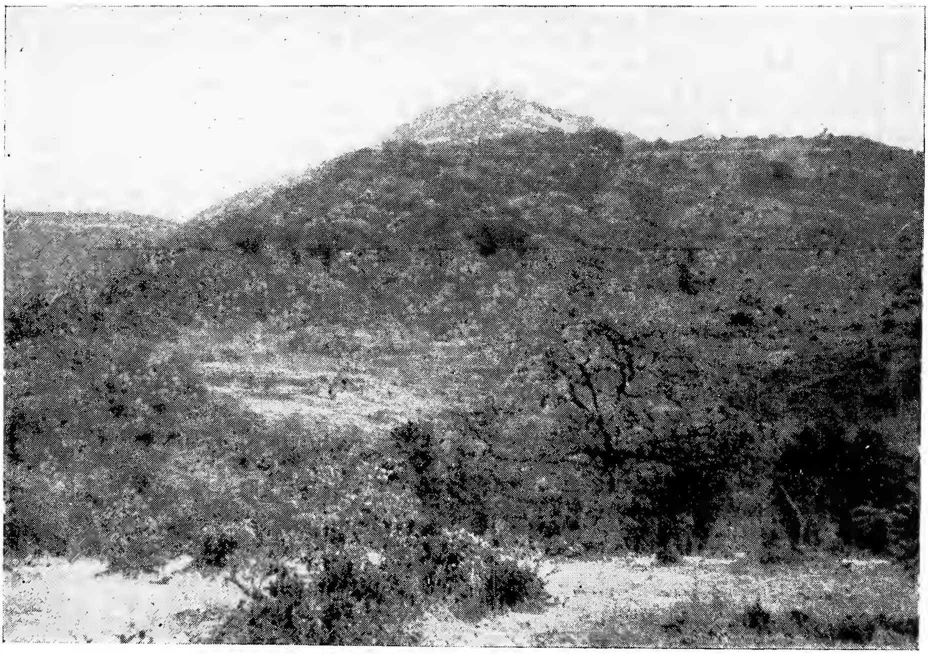

Above: Sacred grove of goddess Janni at Mangaon, Velhe Taluka, Poona District. *Below*: Sacred grove of the saint Somjibuva at Dhaman Vahal, Mulshi Taluka, Poona District.

magnificent specimens of trees and climbers. The larger groves are a veritable treasure-trove for the naturalist, supporting many species of plants which are rare in the area, and are becoming rarer and rarer with the deforestation which seems to gather pace daily. These sacred groves are also often serving as a last refuge for arboreal birds and mammals especially monkeys, and no doubt for other forest loving animals as well (Plate).

Two examples

We will illustrate the phenomenon of these sacred groves with the help of two examples from Maharashtra; one, a grove of the goddess Janni at Mangaon in Velhe taluka of Poona district and the second, a grove of the goddess Kalkai at Gani in Shrivardhan taluka of Kolaba district. Both are amongst the largest groves that we have visited, being about fifteen hectares in size, and lie along the crestline of the Western Ghats. Both lie in regions which receive about 4000 mm of rainfall during the months of June to September, and consequently support montane subtropical evergreen forests.

Mangaon lies near the southwestern edge of the Panshet reservoir and is at a distance of one km from the motor launch stop at Mangaon. The grove is about three quarters of a kilometre away from the village itself and is situated on a hill slope of about 30° to 40°. About five hectares of this grove was felled in 1948, but this was allowed to grow without further disturbance and is now a good second growth forest. The other ten hectares appear to be in their primaeval condition. This primary forest is composed almost entirely of trees about ten to thirty metres tall with little shrubby or herbaceous undergrowth. The dominating tree species are Yeru (*Dysoxylum binectariferum* Hook. f.), Jamun (*Syzygium cuminii* Skeels) and Anjan (*Memecylon umbellatum* Burm). Particularly remarkable specimens are those of Bhorab (*Sterculia guttata* Roxb.) and Peepar (*Ficus arnottiana* Miq.). The forest is rich in woody climbers notable amongst which are Shikekai (*Acacia rugosa* Ham.) and Ombali (*Gnetum ula* Brong.).

The reigning deity of the grove is a mother goddess, *Janni*. She is now in the form of a simple icon in a primitive temple. However, even this grandeur is recent. Originally she was in the form of uniconic stone lumps smeared with minium lying out in the open. These stones are still in the temple, along with a stone representing the *mulpurusha* or the founder of the Polekar clan of the Mangaon village. The deity demands animal sacrifice and is supposed to be very ferocious in nature. It is believed that the femininity of the deity indicates that the worship originated in the hunting gathering stage of the society which was still

awed by the miracle of birth and in which there was little of male domination. The fact that the temple is fairly recent, and away from the village also supports the conjecture that the cult originated when the society was not yet settled in permanent dwellings (Kosambi 1962).[1]

Removal of any plant material, even of dead wood from the grove is taboo. The villagers seem to respect this taboo with near-complete sincerity even today. Wood from the grove was however occasionally removed in the past with special permission from the deity in case of a disaster such as a major fire in the village. Apart from such, presumably very rare violations, the grove must have been in a completely primaeval condition till 1948. In that year there was a dispute regarding the ownership of the grove between two clans in the village. The dispute was settled by the Government by the entire grove being auctioned for felling. A coal merchant from Poona bought the grove in the auction and commenced felling with the help of imported tribal katkari labourers. The villagers, who were at first unhappy about the destruction of their sacred grove, decided that they should at least make some money if destruction was inevitable. They also felt that it was the merchant who will be subjected to the wrath of the gooddess. They therefore refused to let the katkaris do the felling and volunteered to do the felling themselves but on wages higher than those demanded by the katkaris. This dispute lasted for quite a while, but finally the merchant gave in and the villagers completed about five hectares of felling. At this point there was a further dispute which was terminated with the merchant dying a sudden death vomiting blood. The villagers decided that the death was a just punishment meted out by the goddess because of the violation of her sacred grove. Felling was stopped, and the rest of this magnificent grove was saved from disaster. Today, the rest of the region has been completely deforested and the grove of Janni stands as the last refuge of the magnificent vegetation that covered the entire region till only twenty years ago.

Our second example is from Konkan. The village of Gani is about twenty kilometres from Shrivardhan isolated atop a hill plateau. The base of the hill may be reached by a bus, or jeep but one has to climb a distance of five kilometres before reaching the village. The sacred grove of Kalkai lies about half a kilometre from the village itself and is situated on a gentle slope. The grove is about fifteen hectares in area and all of it is in its primaeval state; there has never been any felling in the grove within human memory. The forest is dominated by *Terminalia paniculata* Roth, *Mangifera indica* Linn., *Holegerna grahami* Hook. f., *Alstonia scholarae* R. Bc. and is about twenty to forty metres in height. There is little shrubby undergrowth, but a rich growth of

[1] KOSAMBI, D. D. (1962): Myth and Reality. Popular Book Depot, Bombay.

climbers of species *Gnetum ula* Brong. *Acacia rugosa* Ham., *Combretum ovalifolium* Roxb. and *Schefflera venulosa* Harms. The most remarkable specimen in the grove is a magnificent tree of Garud (*Ficus* sp.) which has a girth exceeding fifteen metres.

The reigning deity of the grove is like that in Mangaon a mother goddess, Kalkai. She is in an uniconic form and lies open to the sky. She demands blood sacrifice. In all these features as well as in lying at a distance from the village, the cult at Gani resembles the Mangaon cult. Removal of any live wood from the grove is taboo. However the taboo on the removal of dead wood and leaf litter appears to have been relaxed within recent times. As with Mangaon, all the region surrounding the village Gani has been completely deforested. The effects of this deforestation which has been more thorough at Gani, are being felt much more acutely by the villagers. They now have no source of fuelwood or of leaf litter for preparing the paddy fields except for the grove. Moreover, apart from a village well, the only perennial source of water is a spring in the grove. Deforestation has led to the drying up of all the other perennial springs in the vicinity of the village. The spring in the grove is therefore the only perennial water source for the cattle, or for the people working in the field.

The villagers of Gani are now acutely aware of the crucial role of the grove in their economy. This grove, as many others, is classified as temple land in the revenue records, and therefore cannot be exploited except at the initiative of the temple trust. The villagers, as trustees, have no wish to destroy this last source of fuel and water. It so happened, however, that part of the grove was classified as forest land. As this coupe was due for felling by rotation in 1972, some of the trees from the grove were marked for felling by the departmental personnel. The villagers were very unhappy at this, and on being informed by some forest department official of our interest in the sacred groves wrote to us for help. We visited the grove and were convinced of the merit of the villagers' case. We are very happy to state that the forest department very considerately halted the felling in the grove at our request.

Geographical Distribution

Such sacred groves are a very ancient and widespread phenomenon in the old world cultures. They are mentioned in Greek and Sanskrit classics and are reported to exist today in a number of countries besides India e.g. Ghana, Nigeria, Syria, Turkey. We have not come across any comprehensive account of the sacred groves, and this list based on personal conversations with other naturalists is definitely very incomplete. It appears, however, that this phenomenon is entirely unknown in the

New World (R. E. Schultes, personal communication). In India they have been reported to us from the entire length of the Western Ghats, in Maharashtra, Mysore and Kerala. The reigning deities of the groves in Mysore and Kerala are cobras rather than mother goddesses as in Maharashtra. Aravalli hills in Rajasthan have groves dedicated to a mother goddess Jogmaya (I. Prakash, personal communication). Sacred groves are also found in the hill states of northeastern India, and in fact are notable for harbouring rare species of orchids (A. G. Raddi, personal communication).

The finest sacred groves of India presumably occur in the Sarguja district of Madhya Pradesh (G. G. Takle, personal communication). Here every village in the area has a grove about 20 hectares in extent. What is remarkable is that not only plant, but also animal life receives absolute protection in these groves. The groves therefore serve as sanctuaries for herds of ungulates as well. These groves are locally known as sarana forests, a word which probably derives from the Sanskrit "sharana" or sanctuary.

Economic Significance

It is well known that the climax form of vegetation in any locality often tends to be richer in species than the earlier stages of succession. As climax forests, the sacred groves are particularly diverse in species of trees and the life forms dependent for their existence on trees, namely climbers and epiphytes. With the felling of forest all around them, the sacred groves have become the last refuge of many plant species. Many of the plant species which depend for their very survival in the region on the sacred groves are of considerable practical value. A striking example of this was provided by the grove at the village of Tunbad in Shrivardhan Taluka. This rather small grove harboured a magnificent specimen of Garabi or Gaidhari (*Entada phaseoloides* Merr.) a leguminous climber. The local inhabitants use the bark of this climber in treating cattle against snakebite. We were told that this was the only specimen of this species within a radius of 40 kilometres, and people came up from considerable distances to this grove for the medicinal bark. It is certain that many species now preserved in the sacred groves possess such medicinal properties and may prove to be of considerable economic value if properly studied and exploited.

Apart from the preservation of rare species the sacred groves may be serving the function of preservation of biological diversity even in the case of commoner species of trees. Thus we have been told of two groves in Maharashtra which support ancient Teak (*Tectona grandis*) forests although teak has disappeared from the vicinity of those groves

(1) Dhamani in Junnar Taluka of Poona district; (Shri U. K. Mavinkurve, personal communication) and Dapora in Wani Taluka of Yeotmal district (Shri M. G. Gogate, personal communication). It is very likely that the teak specimens in these groves represent genetic variants which are peculiar to that geographical region. Experience with forest tree breeding programmes in North America has shown that the success of such programmes depends crucially on the availability of abundant genetic variation over the entire geographical range of the species. The genetic variation of species like Teak likely to be preserved in the sacred groves may therefore prove to be of great value in a future forest tree breeding programme in India.

Conservation

Continued conservation of these sacred groves is obviously desirable both from a practical and an aesthetic point of view. Unfortunately, the religious beliefs on which this conservation was based are beginning to weaken at the same time as the need for their conservation is becoming more and more urgent with the deforestation of the surrounding regions. Both the sacred groves described in detail above have been just saved from threats of destruction. Many others have succumbed. The larger, more valuable sacred groves are in fact more susceptible because they can fetch considerable money in the short run for the poor farmers. For example, there were originally four sacred groves of an area greater than five hectares in the Panshet reservoir catchment area. Two of these, one at Shirkoli and the second at Gondekhal, both of fifteen hectares each, were felled in 1956. A third, at Tav is likely to be felled in the next one or two years. That at Mangaon continues to be coveted by charcoal merchants. We were told that just last year a merchant offered the village headman a bribe to agree to bid as a dummy in an auction the merchant was hoping to arrange.

All of this obviously points to the need for immediate measures to conserve all the remaining sacred groves of substantial extent. Most of these are classified as lands reserved for a temple. The land may be owned either by the Government or privately. Where the land is under governmental control the logical measure is to turn it over to the forest department which can classify these groves as preservation plots. It is, however, the privately owned groves that are in more imminent need of protection. Those mentioned above as already felled at Shirkoli and Gondekhal were privately owned, and so is that at Tav likely to be felled very soon. Such privately owned groves could probably be best preserved through the good offices of charity commissioners who regulate the functioning of the religious trusts. This could be accomplished by

the charity commissioners adopting the view that the grove associated with a temple is an important asset that the trustees must preserve. We are also happy to note that the Flora Wing of the Indian Board of Wild Life is considering the possibility of setting up a system of nature preserves to protect the sacred groves of northeastern India. It would be obviously desirable to extend the scope of such a system to embrace all of India.

Summary

Scattered, apparently throughout India, are a large number of forest tracts which have remained immune from human interference because of religious beliefs. As deforestation has been taking place at a rapid rate in many areas, such forests have come to be the only remnants of the original forest in a number of cases. Because of the absence of human interference the sacred forests support the climax vegetation appropriate for their particular locality. Such a climax vegetation is very rich in species of trees, climbers and epiphytes. As such these sacred groves serve the vital function of preservation of plant species which have become very rare or extinct elsewhere. Preservation of these species could be of great economic significance. Some of the species so preserved are already of medicinal significance; others could acquire such a significance in future. Even in the case of species not in any danger of extinction, the sacred forests may serve to preserve genotypes which may be useful in a future forest tree breeding programme. The sacred forests are also of great silvicultural interest as indicators of the natural productivity of the region. It is, therefore, imperative to survey these sacred forests and properly assess their role in nature conservation so that these forests may continue to be preserved even if the religious beliefs associated with them weaken and may disappear.

Acknowledgements

It is a pleasure to acknowledge the willing help received from many officials of the Maharashtra State Forest Department in our survey of the sacred groves of Maharashtra. We would particularly like to mention Shri V. D. Mehendale, Additional Chief Conservator of Forests for Maharashtra, without whose interest this project could not have been pursued. Many others have helped with information and these have been acknowledged in the text. We are also thankful to Drs. G. B. Deodikar and T. S. Mahabale for their encouragement and for generously supporting this research through the facilities of the Maharashtra Association for the Cultivation of Science.

Hunting and feeding in wild dogs[1]

MICHAEL FOX[2] AND A. J. T. JOHNSINGH[3]

(*With a graph*)

These observations are based on our preliminary study of the Indian Wild Dog (*Cuon alpinus*) in the Mudumalai Sanctuary, Tamil Nadu.

Wild Dogs at Mudumalai usually hunt in the early hours of the morning between 6 and 8 a.m. They generally avoid strenuous activity during the heat of the day, seeking shade under rocks, dense underbrush or lying in along the banks of a river. This behavioural thermoregulation greatly influences the daily activity and movements of these dogs living in the tropical and subtropical regions. In cooler seasons they may be active and hunt at any time of the day. They rarely hunt at night but are most active on moonlight nights. This implies that they rely greatly on the sense of sight for hunting. But, in fact, all senses including those of sound and smell, are used flexibly without any particular specialization on any one modality.

During our two month study we were lucky to see a vain attack by wild dogs on a gaur calf which was protected by the determined mother and other members of the herd. Yet the agility and tenacity of the wild dogs gave us an idea of how they tackle a large prey such as the spotted deer or sambar. Further, four fresh kills were discovered before the vultures and other scavengers had arrived to remove everything. They were in varying degrees of mutilation and by the various signs that the dogs had left it was possible to piece together how the prey is brought down and dismembered.

It is highly probable that one of the dogs seizes the deer by the nose, which, like a twitch on a horse, must greatly inhibit its movements. Other dogs attack the hind end, biting the thighs, buttocks and flanks. One dog may secure a hold on the tail and with the other on the nose, one or two dogs on the ears and the rest of the pack pulling at the prey's flanks and hind quarters, a tug-of-war ensues. The prey is pulled down and if it is a fawn it is literally torn apart. There is no killing bite as in the big cats to dispatch the prey swiftly. The wild dogs, although they

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have powerful jaws, have relatively short canine teeth which could not be used to serve the spinal cord of larger prey. These shorter canine teeth, aided by the outer upper incisors which are curved and have evolved into a pair of secondary canines, enable the wild dog to secure a hold on the prey. The sight of several dogs securely attached to the prey and pulling, twisting and tearing at it, has shocked many a hunter who sees the wild dog as bloody killers. They are indeed messy, having no clean and efficient way of killing their prey.

When the flanks are torn open, the prey may be eviscerated as it struggles or is dragged along the ground by other dogs at the head end. The liver, kidneys and the lungs may be eaten and some sections of the intestines except the stomach and rumen which are torn out and left untouched. Similarly with the wildpig, the stomach was untouched by the dogs. The dogs may eat portions of the animal that are torn off as it struggles. Hence the frequent observation that the wild dog will even eat their prey while it is still alive.

The eyelids and eyes may also be eaten. It has been said that the dogs bite out the eyes of the deer and blind them first. Considering the difficulty a wild dog would have in seizing the eyeball, retracted deep into the orbit by retractor oculi muscles as a defensive reflex, this interpretation is unlikely. Rather the dogs remove the eyes when the prey is dead or immobilized in shock, prior to death.

In the absence of a killing bite, what physical stimulus kills the prey? Young fawns suffering from multiple bite injuries have been rescued from wild dogs and they have recovered; others have 'played dead' (the tonic immobility reaction) and suffering from less extensive injuries, were able to run off, once the dogs were chased away. (Davidar: personal communication). Presumably the prey goes into a state of shock, death ensuing rapidly after evisceration, this latter not being the major physical stimulus that kills the prey. In the absence of evisceration, the onset of shock may be prolonged and wild dogs would have to fight with the prey longer and, possibly, sustain injuries themselves during the attack. What more efficient method then, in the absence of more effective weapons, than to disembowel the prey? An understanding of these facts will hopefully give to the hunter and naturalist a clearer understanding of why the wild dogs seem to be such bloody killers.

Analysis of wild dog faeces shows the presence of fur, skin, hooves, and teeth of fawns and large quantities of digested bone, which has the consistency of fine chalk. It would be highly adaptive for the wild dogs to ingest fur to protect the alimentary tract from possible injury, especially from the extremely sharp bone spicules from small mammals. It was often with much difficulty that we were able to remove the matted fur that formed tight wads and balls around these splinters of bone. Clearly, if carnivores in captivity are fed on small mammals such as

hares, the carcass should not be skinned but left intact so that the ingested fur may be used to form a protective bolus around any fragments of ingested bone.

The composition of successive stools passed by one dog reflected even more of their eating habits. Some stools contained little or no hair, but mainly dark digested meat protein and occasional strips of partially digested muscle and tendon. Other stools contained fur and a lower proportion of digested protein and bones. Bone fragments were never found in those stools that contained no hair. From this we may conclude that the dogs either purposefully ingested quantities of hair when they also crushed and swallowed bones or in the process of digestion the fur aggregates around the bone fragments and are usually voided together and separate from the meat portion of the meal. Fragments of skull, teeth, claws and ocular lenses embedded in fur attested the fact that small mammals were eaten whole.

A high proportion of sambar remains included ingested grass (*Iseilema prostratum*). One faecal sample contained only grass and twigs; this dog was probably sick since the stool was liquid. The only other vegetable matter ingested in a significant amount was the fruit of *Zizyphus*, which was present in one sample. This fruit is commonly eaten by langur, bonnet macaque, porcupine, spotted deer, pigs and bear. Some fragments of grass, seeds, twigs and bamboo leaves were found in many of the faeces and their presence was probably accidental since a wild dog eating its prey on the ground is bound to pick up such material.

There is no satisfactory answer as to why carnivores eat grass. Like fur it may be an anti-irritant. Grass may also be an important source of vitamins and trace elements not available in the all meat diet, since the stomach contents of chital and pig were not eaten. We were not able to ascertain whether or not the wild dog eviscerated small mammals before eating them but this was certainly the case with the deer and the wild pig.

To determine the predation by wild dog on the deer population of our study area we collected the pelvises and lower jaws of deer. Of the sixty-three pelvises collected fifty-six were chital and the remaining seven sambar. Sex ratios were 23 male to 33 female chital and 5 female to 1 male sambar. (One fragment of pelvis could not be sexed).

In order to gain some insight into the degree of maturity of these kills pelvic index was taken by measuring the distance from the top (anterior rim) of the acetabulum or hip joint and the bottom of the obturator foramen. This index was chosen since it was the most intact region—the ilium and ischium usually being chewed and splintered by the dogs (text figure).

From the figure, it appears that pelvises with an index less than 7.5 cm would be ingested entirely by the wild dogs, since no remains were

found in the field (with the exception of a 2-3 month old fawn killed by three dogs near our camp). This conclusion may not be warranted since a pelvis of 7.5 cm index would be well ossified especially at the region of the acetabulum and could not therefore be easily ingested. It is quite possible then, that wild dogs do not kill many sub-adult fawns with a pelvic index of 6.5-7.5 cm. But this conclusion also may not be warranted, since the field samples were taken in the spring and most fawns would not attain this pelvic index until late summer or autumn. The absence of such remains in the spring collection in this study is an open question. We do not know how long moderately calcified bones remain intact. Their half life may be as short as 2-3 months, since many scavengers, notably porcupines and small rodents, will ingest such bones which constitute a rich source of mineral salts essential to their diet.

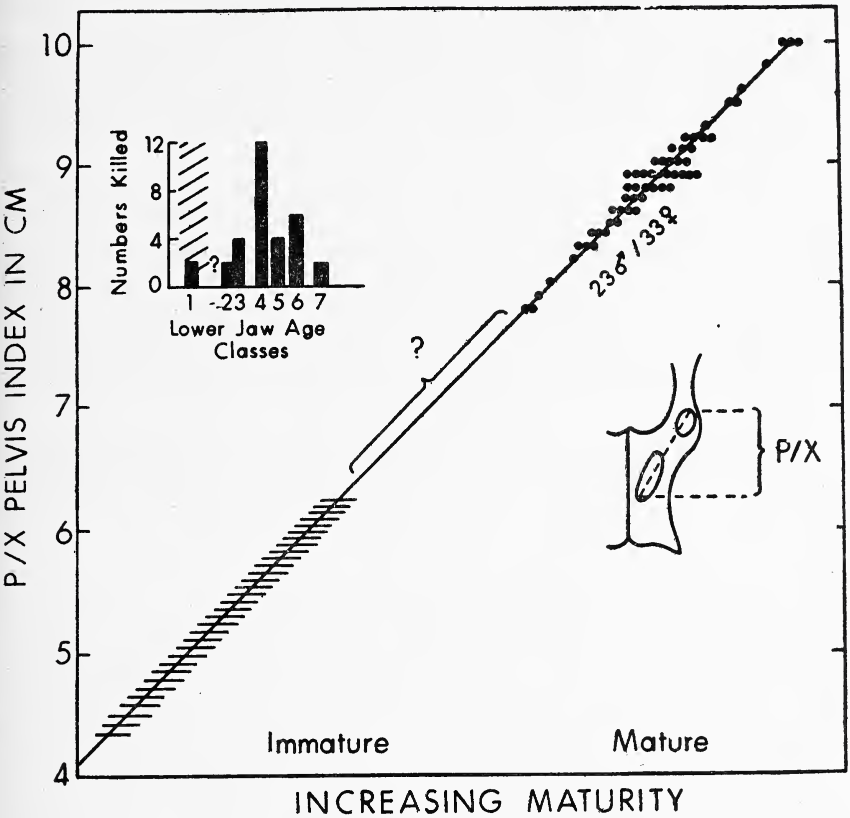
A similar age gap was found in the samples of lower jaws. The same arguments posed above hold for the absence of sub-adult jaws in the collection. Interestingly enough the greatest proportion of kills was in the 4-6 year (prime) age group. This may not be an indication that the wild dogs selectively kill animals of this age, but rather that the majority of animals in the herds fall (with the exception of the large annual fawn crop) within this age group. This conclusion is supported indirectly by the Nilgiri Game Association records of the number of chital shot each year. The numbers have increased greatly over the last few years, indicating that there must be more individuals in the herds which fall into this highly productive age range.

The age classes of kills identified from lower jaws are shown in the figure and this follows Schaller's (1967) age classification based on the wear on various teeth. Class I represents the fawns and in most of these kills the jaws are eaten by the dogs, since we found only two specimens. Classes 2 and 3 are yearlings and young adults and classes 4, 5 and 6 represent prime adults. Class 7 is past prime. Interestingly no really aged specimens were found, indicating that chital in the Nilgiris rarely live over 8 or 10 years of age.

Only eight lower jaws of the Sambar were collected in contrast to 31 lower jaws of the chital and all of these were subadults. Analysis of faeces confirmed the fact that the chital was the most commonly killed prey during the period of study. We were wary about collecting too many faecal samples from the packs because this might have had some effect on their marking behaviour since the faeces were deposited mainly at communal dunging areas.

The ratio of chital to sambar remains found in the faeces was very close to the ratio of chital to sambar pelvises that were collected in the field (approximately 10:1.5 or for every twenty chital killed three sambar). This ratio accords with the lower population of sambar and with the fact that these deer are very large and powerful and difficult for the

wild dogs to bring down. Presumably the wild dogs kill mainly fawns and subadult sambar since no adult lower jaws were found in the study area.



Graph showing age classes of lower jaws and pelvises.

With greater expertise we might have been able to distinguish between the fur of chital fawns, subadults and adults but this was not possible. Judging from the number of faeces containing digested calcium (from the bones of ingested fawns) the ratio of fawns to adults during the period December-February in the samples was in the ratio of 2:1. A complete tail of a fawn, many small tarsal and carpal bones and undigested hooves were commonly found in these faeces.

It has been said that on a long chase the wild dogs run after the prey in relays and this may be a misinterpretation of canid hunting behaviour and has been clarified somewhat by Hugo & Jane van Lawick's observations of cape hunting dogs in their book THE INNOCENT KILLERS. 'As the prey zig-zags in front of the pack it comes closer to some dogs than to others; the closest dog takes up the chase until the prey

again turns wide and another dog closer to it will take over. The open plains of Serengetti where the cape hunting dog lives is very different from the jungle habitat of the wild dog, although a few small clearings have the park-like appearance of this great African plain. Consequently the hunting strategy of the wild dogs would be adapted to the terrain. Running in relays would result when the prey in front of the lead dog turns wide and the dogs in the rear could intercept it by taking a short cut along one of the many narrow game trails that labyrinth through the dense scrub.

Often chital and sambar kills are found near water and this has led to the common deduction that deer at bay will run to water in their attempt to escape. Many kills, however, are made when deer come to water or at traditional crossing points along the river which they use while travelling from one browsing area to another. Another reason for so many kills being made near a river is that the prey takes the swiftest route away from the dogs, which is down hill where, coincidentally, lies the river.

Beyond doubt, our study confirms that the wild dogs are to be left in peace in the Nilgiris as they are the remaining major predators regulating the deer population. Shooting by sportsmen for 'trophy stags' has little value in maintaining the deer population as the fawn, does, young stags and aged stags would rapidly produce a situation of overpopulation, overgrazing and ultimately, enormous deer mortality from starvation and stress disease (aggravated also by competition with indigenous domestic cattle). As the wild dogs kill on a random-chance basis and as they rarely take sub-adult deer, 1-2 years old, which will be highly productive, their predation is ecologically more adaptive than the human pattern of hunting only trophy stags. The question is whether we are going to allow these graceful hunters to do their job undisturbed.

Reference

Schaller, G. B. (1967): The Deer and the Tiger. University Press, Chicago.

A contribution to the Flora of Pacchaimalais, Tiruchirapalli District, Tamil Nadu[1]

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(*With a map*)

Situation and Physical Features

Tiruchirapalli is an inland district of Tamil Nadu, with an area of 14,281 sq km, and comprising the taluks of Tiruchirapalli, Karur, Kulithalai, Lalgudi, Musiri, Perambalur, Udayarpalayam, Alangudi, Kulathur and Thirumayam.

Forests occupy less than 7 per cent of the total area. Of this, the Pacchaimalais ('green hills') lying along the north-western border of the district and rising to 950 m account for the larger share. Irregular in outline, they have a maximum (north-south) length of 32 km. "In plan, the range has a very rude resemblance to an hour-glass in shape, being nearly cut in two by two ravines of great size and depth, opening to the northeast and southwest. Of the two parts thus formed, the north-western is the larger, and has generally a higher level than the south-eastern. Besides the rambling shape of the range, the most noteworthy and striking feature is the great steepness of the western slopes compared with those of the east, which are rarely precipitous, and are broken by sundry long buttress-like spurs, projecting far into the low country" (King & Foote 1864). The total area is 480 sq km of which 274 are in the Tiruchirapalli district, and 206 in the Salem district. The entire southern slopes and parts of the eastern and western slopes fall within the Musiri taluk of the Tiruchirapalli district. The Pacchaimalais of the Tiruchirapalli district are separated from the Kollimalais of the Salem district by the narrow Thammampatty valley.

Situated 70 km from the town of Tiruchirapalli and at the foothills of the Pacchaimalais is the small village of Sobanapuram. At the centre of the plateau of the Pacchaimalais is the village of Top Sengattupatty, with an Inspection Bungalow the only place suitable for camping on the

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plateau. The two villages are connected by a 10 km bridle path, now being replaced by a motorable road.

Soil: The rocks are geneissic, with pockets of cretaceous sedimentary deposits. The soil varies in texture from sandy loam to loam. On the slopes it is dry, stony, poor in humus, and even less than 1 m deep, while the plateau has deep sandy loam with a good admixture of humus. There has been considerable erosion, accelerated by various forms of mismanagement like overexploitation, overgrazing, or even destruction of forests for shifting cultivation.

Climate: Whereas the district as a whole is characterized by a warm climate with low humidity, the Pacchaimalais have a relatively moderate climate owing to altitude and vegetation.

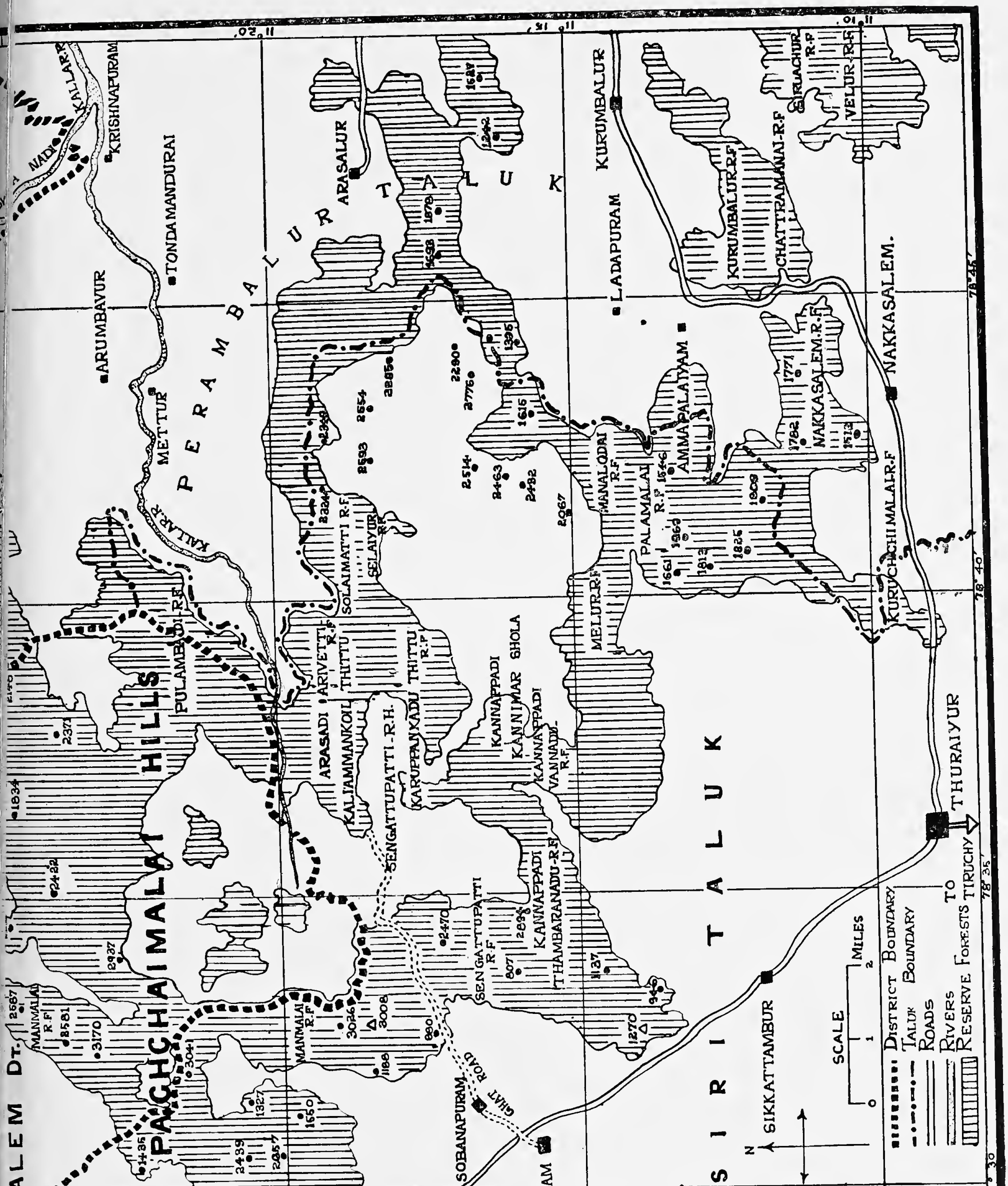
More than half of the mean annual rainfall of about 130 cm is received during the northeastern monsoon in October-November. The southwest monsoon is generally light; occasional summer showers also occur. The plateau is said to be malarial.

People: The portion of the Pacchaimalais within the Tiruchirapalli district has three *nadus* or groups of villages—Vannadu with 19 villages, Tanparanadu with 16 and Kambainadu with 13. The inhabitants are 'Malaiyalees' ('hill men'). Agriculturists of the hills (cultivating just the mere essentials of subsistence like cereals and pulses), sparsely dressed, speaking a dialect of Tamil, these people are a well-knit group, with their own family, social and religious customs and agricultural practices. Education or anything like modern amenities have scarcely reached them; their only contact with the outside world is the weekly trek down the hills to the plains for marketing. The general shyness of these people hides a great store of unassumed friendliness. Sociologists will find the habits, customs and community organization worth study.

Vegetation: The forests are of the *Southern Tropical Dry Deciduous* (Champion 1961) type. Below 450 m the forests, within easy access of the villages around, are much degraded owing to heavy grazing or random fellings. The vegetation is rather sparse and regeneration poor. Among the more dominant species are *Acacia leucophloea, Chloroxylon swietenia, Dichrostachys cinerea, Erythroxylon monogynum, Zizyphus leucopyrus, Tamarindus indica, Randia dumetorum, Memecylon edule* and *Dodonea viscosa.*

On the upper slopes, however, the forests are denser owing to better growth conditions and less interference; besides the species mentioned, are *Maba buxifolia, Murraya koenigii, Carissa spinarum, Elaeagnus indica,* and *Scutia circumcissa.* Sandalwood is the main item of forest revenue in these forests. Bamboos are occasionally present; the few climbers are large and woody; ferns and epiphytes are scarce except at the higher altitudes.

Patches of *Southern Subtropical Hills Forests* occur in the plateau



Map of the Pachchaimalai Hills.

areas of Karuppankadu Thittu and Sholamadevi, where annual rainfall exceeds 120 cm, and trees exceed 20 m tall, with a lower shrubby, mostly evergreen, layer.

There has been considerable human interference in the form of destruction of forests for shifting cultivation. One obvious consequence is the invasion of *Lantana camara* var. *aculeata* and *Dodonea viscosa*. *Stachytarpheta urticaefolia* is the most conspicuous weed of neglected gardens, where they form dense masses. Exotic ornamental species are scarce. The first plant colonizers on the motor road under construction are *Tridax, Vernonia, Tephrosia, Corchorus, Dolichos, Ipomoea, Sida* and several species of grasses.

The crops of the plateau consist of cereals like *Oryza sativa, Pennisetum typhoides, Sorghum vulgare, Eleusine corocana, Setaria italica, Panicum miliare, Paspalum scrobiculatum;* pulses and vegetables like *Dolichos lablab, Vigna sativa, Phaseolus mungo, Phaseolus radiatus, Dolichos biflorus, Brassica juncea, Capsicum annuum;* and cash crops like *Sesamum indicum*. Coconut and bananas are seen around habitations.

The presence of some very old trees of *Terminalia* spp., *Artocarpus heterophyllus, Ficus bengalensis, Diospyros* spp. suggests that certain tracts of the interior have not been tampered with; even in the villages themselves, the scarcity of introduced species, of economic or aesthetic value, is noteworthy.

The Scope of the Present Exploration

The Pacchaimalais have so far not been exhaustively explored (Sebastine & Henry 1961) though the region does show certain interesting features. There are several species of restricted distribution that verge on the endemic; many more species are new records to the Tiruchirapalli district.

Ethnobotanical studies have considerable scope here on account of the intimate knowledge of plants possessed by the Malaiyalees. Deprived of modern medical amenities, these people depend on plants for medicines. The fact that each family seldom has more than a child or two, may suggest that the people depend on some plant of contraceptive value. Certain individuals in every village are known for their intimate knowledge of plants—in fact the author realized that such a Malaiyalee companion was indispensable for good field work. The local names and uses of plants given below are largely taken from data given by such a field assistant.

The distributional notes under each species are given under one of three headings: 'at the foothills' (chiefly around Sobanapuram), ('on the slopes' (ghats), and/or 'on the plateau' (chiefly at Top Sengattupatty, Karuppankadu Thittu, Kaliammankovil Thittu, Masimalaiyan

Thittu and Kannimar Shola). The notes refer to the actual places of collection *without* suggesting anything about the overall distribution of the species on the Pacchaimalais. The paper summarises the work of two collection trips—in December 1969 and July 1970. It is of a preliminary nature, reporting the first attempts towards an eventual *Flora* of the district.

Identification of the plants was done personally by me at the Madras Herbarium, Coimbatore. The collections are preserved in the Rapinat Herbarium, St. Joseph's College, Tiruchirapalli. The following enumeration consisting of 349 species from 269 genera belonging to 82 Families follows Gamble & Fischer (1956) for the order of the Families; genera and species are given in alphabetical order. Nomenclature has been brought up to date as far as possible; Tamil names, given in brackets closely following the botanical name, have generally been collected or verified in the field, failing which they have been taken from Seshagiri Rao & Krishnaswamy (1941).

Enumeration of species

Ranunculaceae

Clematis gouriana Roxb. ex DC.

An extensive climber; leaves highly variable in shape; flowers white, in dense axillary or terminal panicles; common on the plateau.

Naravelia zeylanica DC.

On the upper slopes and on the plateau; usually spreading on thickets, etc.

Menispermaceae

Cissampelos pareira L. (Appatta)

A tomentose climber; on the plateau.

Cyclaea peltata (Lamk.) Hook. f. & Th.

A climbing shrub with peltate leaves; on the plateau.

Diploclisia glaucescens (Bl.) Diels

A woody climber with small yellow flowers on the old stem; on the plateau.

Stephania japonica (Thunb.) Miers

A climber with small flowers in axillary umbels; on the plateau.

Capparaceae

Capparis sepiaria L. (Thoratti)

A large straggler with hooked thorns and small white flowers; the petals fall early; on the upper slopes and on the plateau.

Violaceae

Hybanthus enneaspermus (L.) F. Muell. (Orilaithamarai)
(*Ionidium suffruticosum* Ging)
A small herb with solitary pink flowers; along the slopes.

Bixaceae

Flacourtia indica (Burm. f.) Merr. (Sothaippallu; Sottaikala)
(*F. sepiaria* Roxb.)
A dense shrub with small green flowers; fruits said to be harmful to teeth; abundant on the plateau.

Scolopia crenata Clos.
An armed tree up to 8 m tall; flowers small, white, with spreading stamens and thick styles; abundant on the plateau.

Pittosporaceae

Pittosporum floribundum Wt. & Arn. (Kattusampangi)
A tree up to 12 m tall, with white flowers in terminal panicles; on the plateau in the forests.

Polygalaceae

Polygala javana DC.
Several branches from a woody base; flowers relatively large, pink; plants seldom seen entire owing to grazing; common on the slopes.

Malvaceae

Hibiscus vitifolius L. (Manithuthi)
A shrub with yellow flowers; on the plateau, near habitations.

Malvastrum coromandelianum Garcke
A weed of wastelands on the plateau.

Pavonia procumbens Boiss.
An undershrub with white flowers; on the slopes and on the plateau.

Pavonia zeylanica Cav. (Mammatti)
An undershrub with pinkish flowers; on the slopes.

Sida rhombifolia L. (Tenacham)
A shrub with yellow flowers; on the slopes and on the plateau.

Urena lobata L. (Ottati)
A weed of wastelands; flowers pinkish.

Sterculiaceae

Helicteres isora L. (Valambiri)
A tree up to 10 m tall, with red flowers and spirally twisted follicles; on the plateau.

Pterospermum obtusifolium Wt. (Mulipolavu)

A small tree on the slopes; reported to be scarce by Gamble.

Pterospermum xylocarpum (Gaertn.) Sant. & Wagh (Odupai)

(*P. heyneanum* Vahl)

A tree of the plateau forests; numerous seedlings as undergrowth.

Waltheria indica L.

An undershrub with reddish stems and yellow flowers; one of the first colonizers on the freshly cut road.

TILIACEAE

Corchorus ? **olitorius** L. (Sanal; Peratti)

Robust specimens seen along the newly cut ghat road; not seen elsewhere.

Corchorus tridens L.

Same as above.

Grewia disperma Rottl. ex Spreng. (Anaikkatimaram)

A small tree; fruit conspicuously 2-lobed, covered with golden tomentum.

Grewia emarginata Wt. & Arn.

A large shrub with leaves whitish on the undersurface.

Grewia flavescens Juss. (Karichili)

A small tree with yellowish flowers; on the slopes.

Grewia orientalis L.

A shrub with long arching branches and white flowers; throughout the range.

Grewia rhamnifolia Heyne

A tree; throughout the range.

Grewia tiliaefolia Vahl (Thadachi)

A tree of the plateau forests.

Grewia umbellifera Bedd.

A shrub up to 4 m tall; on the plateau.

LINACEAE

Hugonia mystax L. (Mothirakkanni)

A straggling shrub with extensive branch system spreading on the trees; flowers bright yellow, showy, aggregated at the apices of branches; fruits red when ripe; on the slopes.

Erythroxylon monogynum Roxb. (Sembulichai)

A spreading shrub up to 3 m tall; flowers yellow; ripe fruits red; throughout the range.

MALPIGHIACEAE

Hiptage madablota Gaertn. (Kurukathi)

A woody straggler; leaves said to be used for smoking by the local people; on the plateau.

Geraniaceae

Oxalis corniculata L. (Puliyarai)
A diffuse creeper with yellow flowers; common on the plateau.

Rutaceae

Atalantia monophylla Correa (Kattu Elumichi)
An armed tree up to 12 m tall; on the plateau.
Chloroxylon swietenia DC. (Vamparai)
A large shrub or small tree with pinnate leaves; the dehisced capsules persist for long; throughout the range.
Clausena dentata (Wlild.) R. & S. (Aanai)
C. willdenovii Wt. & Arn.
A large shrub or small tree; aromatic leaves said to hasten the ripening of fruits like bananas in storage; on the plateau.
Evodia lunu-ankenda (Gaertn.) Merr. (Kattushanbagam)
A densely foliaceous tree over 20 m tall, with copious flowers; on the plateau.
Feronia limonia (L.) Swingle (Vilamaram)
F. elephantum Correa
Occasional trees on the plateau.
Glycosmis cochinchinensis Pierre (Kulapanai)
A large shrub or small tree up to 5 m tall; on the slopes and on the plateau.
Murraya koenigii (L.) Spr. (Karuveppilai)
A shrub with aromatic leaves used in cooking; one of the most dominant species on the plateau.
Pleiospermium alatum (Wall. ex Wt. & Arn.) Swingle
Limonia alata Wt. & Arn.
A densely foliaceous tree with winged leaves; throughout the range.
Toddalia asiatica Lam. (Milagaranai)
A prickly straggler with greenish flowers; on the plateau.

Ochnaceae

Ochna ? squarrosa L. (Kalkuruvi)
A large shrub or small tree with yellow flowers; on the plateau.

Burseraceae

Commiphora caudata (Wt. & Arn.) Engl. (Pachaikkiluvai)
A large shrub or small tree, the thin bark flaking off exposing the green bark; on the slopes.

Meliaceae

Aglaia elaeagnoidea (Juss.) Benth. (Chokla)
A. roxburghiana Hiern.
A tree over 15 m tall, in the forests of the plateau.

Cipadessa baccifera (Roth.) Miq. (Savattuchedi)
A shrub of the forest margins on the plateau.

Soymida febrifuga Juss. (Somadanam)
A tree over 12 m tall with large, ovate, woody capsules; planted at the Top Sengattupatty Rest House.

Olacaceae

Olax scandens Roxb. (Kadalranchi)
A thorny shrub with arching branches and yellowish flowers; at the foothills.

Opiliaceae

Cansjera rheedii Gmel.
An armed shrub with arching branches and dark green leaves; on the plateau.

Opilia amentacea Roxb.
A straggler with pendulous racemes and oblong drupes.

Celastraceae

Celastrus paniculata Willd. (Manjakadi)
A straggler with crenulate leaves, and white flowers in pendulous panicles; throughout the range.

Elaeodendron glaucum Pers. (Kanniramaram)
A tree of the plateau forests.

Maytenus emarginata (Willd.) Ding Hou
Gymnosporia emarginata Laws.
A common shrub of the plateau; the thorns on the apical portions of shoots are longer, and bear leaves and flowers.

Maytenus heyneana (Roth.) Raju & Babu
Gymnosporia heyneana Laws.
A woody shrub with woody thorns up to 3 cm long on the older stem; on the plateau.

Rhamnaceae

Sageretia filiformis (Roth.) Don
S. parviflora R. Br.
A shrub with arching branches; on the slopes.

Scutia circumcissa (L.f.) Druce (Kokkimullu)
S. myrtina Kurz
A strongly armed shrub abundant on the slopes.
Ventilago maderaspatana Gaertn. (Vennyangodi; Karadikkodi)
A climbing shrub; on the plateau.
Zizyphus oenoplia Mill. (Kattu Elanthai; Churaimullu)
A large, very thorny shrub; throughout the range.
Zizyphus xylopyrus Willd. (Kottai Ilanthai)
A tree of the foothills with velvety leaves when young and large fruits.

Vitaceae

Cayratia pedata (Vahl) Gagnep. (Kattupirandai)
A scandent shrub with pubescent leaves; on the plateau.
Cissus quadrangularis L. (Perandai)
The leaves are notably persistent; on the slopes.
Cissus vitiginea L.
A trailing shrub along the slopes.
Leea crispa L.
A shrub usually at the borders of forests, on the plateau.

Sapindaceae

Cardiospermum canescens Wall.
Mature capsules globose, not winged; on the plateau, not common.
Cardiospermum halicacabum L. (Modakkathan)
Mature capsules elongated, winged; at the foothills and on the slopes.
Dodonea viscosa L.
Abundant in the forest clearings on the plateau.
Filicium decipiens Thw. (Athadali)
A densely foliaceous tree of the plateau forests.
Sapindus emarginatus Vahl (Naikottai)
A tree yielding fruits which are locally used as substitute for soap; throughout the range.
Schleichera oleosa (Lour.) Oken.
S. trijuga Willd.
A large tree over 30 m tall; on the plateau.

Anacardiaceae

Rhus mysorensis Heyne (Chippamaram; Sappula)
An armed, dense shrub with numerous arching branches and small, yellowish flowers.

MORINGACEAE

Moringa oleifera Lamk. (Murungai)
Planted near habitations on the plateau.

PAPILIONACEAE

Alysicarpus ? **longifolius** Wt. & Arn.
A stout undershrub with prominently veined leaves; along the slopes.

Alysicarpus vaginalis (L.) DC. var. **nummularifolia** Baker
A herb of unweeded gardens, pasture lands, etc.; on the plateau.

Atylosia albicans Benth.
A twiner noted for the whitish foliage and large yellow flowers; abundant on the plateau.

Canavalia ensiformis DC. (Valavarai)
A twiner from the woody base; flowers purple; along the slopes and on the plateau.

Crotalaria medicaginea Lamk.
A low herb with rather showy yellow flowers; throughout the range.

Crotalaria nana Burm.
A prostrate herb with small, yellow flowers; on the plateau, in pasture lands.

Dalbergia paniculata Roxb. (Porapatchalai)
A tree on the slopes; not common.

Desmodium gangeticum (L.) DC. (Pulladi)
An erect undershrub with lilac-tinged flowers; on the plateau.

Desmodium triflorum (L.) DC. (Sirupulladi)
A profusely branched creeping herb, rooting at the nodes, forming dense mats on the ground; flowers purple; on the plateau.

Dolichos falcatus Klein ex Willd.
A wiry twiner on the slopes and on the plateau; flowers yellow.

Indigofera colutella (Burm. f.) Merr.
I. viscosa Lamk.
A branched subshrub along the slopes; flowers red.

Indigofera cordifolia Heyne
A prostrate herb conspicuous for the silky white foliage; abundant at the foothills.

Indigofera linifolia Retz.
A prostrate, well-branched herb; abundant at the foothills.

Mucuna atropurpurea DC. (Kakkavali)
A woody climber; pods covered with yellow to brown irritant bristles; pods 2-seeded; on the plateau.

Pongamia pinnata (L.) Pierre (Pungu)
P. glabra Vent.
A densely foliaceous tree, with tubercled bark; on the plateau.

Tephrosia hirta Ham.
An erect subshrub of the foothills and slopes.

Tephrosia tinctoria Pers.
A pubescent subshrub from a woody stock; flowers red; on the plateau.

Zornia gibbosa Span.
Z. diphylla (L.) Pers.
A diffuse herb with yellow flowers and prickly pods; foothills and slopes.

Caesalpiniaceae

Bauhinia racemosa Lamk. (Athi)
A deciduous tree up to 10 m tall; common at the foothills.

Caesalpinia crista L. (Kalachikkai)
A very thorny, massive straggler with yellow flowers; along the slopes.

Caesalpinia decapetala (Roth.) Alst. (Putthadukki)
C. sepiaria Roxb.
A very pubescent thorny shrub ascending to several metres along nearby trees, etc.; flowers yellow; on the slopes and on the plateau.

Cassia auriculata L. (Aavaram)
A shrub less than 1 m tall; flowers bright yellow; common in open ground at the foothills. Plants in the areas are notably smaller than elsewhere in the district.

Cassia fistula L. (Sarakkonnai)
Stray trees on the plateau; apparently less luxuriant than in the plains.

Cassia occidentalis L. (Ponnavarai; **Thagarai)**
In wastelands near habitations on the plateau.

Cassia siamea Lamk. (Manjakkonnai)
A tree with bright yellow flowers and coppery pods; on the plateau.

Delonix regia (Boj.) Raf. (Valnarayanamaram)
Stray trees near habitations on the plateau.

Pterolobium indicum A. Rich. (Karu Indu)
A very thorny straggler with white flowers and reddish young pods; really abundant at the foothills and along the slopes.

Tamarindus indica L. (Puli)
At the foothills, as an avenue tree.

Mimosaceae

Acacia chundra (Roxb.) Willd. (Karungali)
A. sundra DC.
A tree with copious yellowish flowers; very abundant at the foothills.

Acacia pennata (L.) Willd. (Vellai Indu)

A very thorny straggler with white flowers; common and abundant at the foothills.

Albizzia amara Boiv. (Usil)

A deciduous tree up to 10 m tall, with whitish flowers; foothills and slopes; pods used as substitute for soap.

Dichrostachys cinerea Wt. & Arn. (Vidathalam)

A thorny shrub or tree with spicate flowers pink below and yellow above; common at the foothills.

Mimosa pudica L. (Thottalsurungi)

Common wayside weed on the plateau.

Mimosa rubicaulis Lamk. (Kattusikkai)

A very thorny straggler, near fences; flowers pink.

Crassulaceae

Bryophyllum pinnatum Kurz. (Ranakkalli)

In moist, shady ground rich in humus; on the plateau.

Combretaceae

Anogeissus latifolia Wall. (Vellainagai)

A large, deciduous tree; on the plateau.

Terminalia arjuna Wt. & Arn. (Vellamaruthu)

A large, usually buttressed tree, over 30 m tall; on the plateau, near rivulets.

Terminalia chebula Retz. (Kadukkai)

A large tree over 30 m tall, common in the forests of the plateau; fruits yield a local tanning material.

Terminalia paniculata Roth. (Pulavaimaram)

A large tree over 35 m tall, with dark corrugated bark, heavy horizontally spreading branches, and brown, winged fruits; on the plateau.

Myrtaceae

Psidium guajava L.

Planted on the plateau.

Syzygium cumini (L.) Skeels (Navalmaram)

S. jambolanum DC.

A large tree over 25 m tall; near streams on the plateau.

Lecythidaceae

Careya arborea Roxb. (Aamimaram)

A densely foliaceous tree up to 15 m tall; on the plateau.

Melastomataceae

Memecylon edule Roxb.

A large shrub or small tree with blue flowers and dark purple fruits; on the plateau.

Memecylon umbellatum Burm. f. (Kasamaram)

A shrub with yellowish leaves and small, yellow berries.

Lythraceae

Ammannia baccifera L. (Neermael Neruppu)

In paddy fields; on the plateau.

Onagraceae

Ludwigia octovalvis (Jacq.) Raven

Jussiaea suffruticosa L.

An erect, pubescent undershrub, with green stems; in marshy places on the plateau.

Ludwigia perennis L. Roxb.

L. parviflora

A decumbent, glabrous herb with purple stems, reddish leaves and yellow flowers; in the marsh on the plateau.

Passifloraceae

Passiflora calcarata Mast.

Along thickets, etc., on the plateau.

Cucurbitaceae

Melothria heterophylla (Lour.) Cogn. (Pulivanji)

A climber with polymorphic leaves and striped fruits; on the plateau.

Momordica charantia L. (Pavai)

Near habitations on the plateau.

Begoniaceae

Begonia malabarica Lamk.

A branched, succulent herb up to 1 m tall, with white flowers, in the crevices of rocks in the shade, at higher altitudes on the plateau.

Aizoaceae

Mollugo pentaphylla L. (Parpadagam)

On the slopes and on the plateau. This is the only species of the genus collected on these hills.

UMBELLIFERAE

Centella asiatica (L.) Urban (Vallarai)
On the plateau, in pasturelands.

ARALIACEAE

Schefflera racemosa Harms. (Kanagi)
A large tree of the forests on the plateau.
Schefflera stellata Harms.
A straggler or a tree near rocks in the forests on the plateau.

ALANGIACEAE

A small tree, at times spinous; on the plateau.

Alangium salvifolium (L.f.) Wang. (Azhingimaram)

RUBIACEAE

Adina cordifolia (Roxb.) Hook. f. ex Brandis (Manjakkadambai)
A tree of the plateau forests.
Borreria articulata (L.f.) F.N. Will. (Nathaichuri)
B. hispida (K. Schum.); *Spermacoce hispida* L.
A hispid, procumbent herb of pasturelands; throughout the range.
Borreria ocymoides DC.
An erect herb with small white flowers; at the foothills.
Canthium dicoccum (Gaertn.) T. & B. (Naluvai; Nallamandaram)
Plectronia didyma Kurz
An evergreen tree with shining leaves; on the plateau.
Knoxia sumatrensis (Retz.) DC.
K. corymbosa Willd.
An erect herb with lilac flowers; on the plateau; rather scarce.
Oldenlandia corymbosa L.
An erect herb with white flowers on long pedicels; in pasturelands on the plateau.
Pavetta indica L. var. **montana** Thw. (Kuttippilathi)
A large, bushy shrub with white flowers; good fodder for calves and lambs; on the slopes and on the plateau.
Pavetta indica L. var. **tomentosa** Hook. f.
In the forests of the plateau.
Plectronia parviflora Bedd. (Mullukkarai)
A thorny shrub; galls often present; on the plateau.
Randia dumetorum Lamk. (Karai)
A thorny shrub with white flowers; abundant at the foothills.
Randia malabarica Lamk. (Sirukarai)
An erect thorny shrub with fragrant, white flowers and red fruits;

on the slopes.

Tarena asiatica (L.) Alst. (Therani)

(*Chomelia asiatica* Kze.)

A large shrub with shining leaves, drying black; on the plateau.

Xeromphis spinosa (Thunb.) Keay

(*Randia brandisii* Gamb.)

A large shrub with prominently veined leaves; mature fruits 4 cm across; on the plateau.

Compositae

Acanthospermum hispidium DC. (Multhulasi)

A weed of wastelands, especially near habitations; on the plateau.

Ageratum conyzoides L. (Poompillu)

A gregarious herb in unweeded gardens; heads white or violet; on the plateau.

Bidens pilosa L.

A weed of cultivation; on the plateau.

Blainvillea acmella (L.) Philipson

(*B. rhomboidea* Cass.)

A scabrid subshrub with white heads; on the plateau.

Blumea bifoliata DC.

A bushy herb in wasteland near habitations; rays yellow; on the plateau.

Blumea lacera DC. var. **glandulosa** Hook. f. (Narakkarandai)

A glandular hairy herb, abundant in unweeded gardens; heads yellow; on the plateau.

Eclipta prostrata (L.) L.

(*E. alba* Hassk.)

A herb of moist places; heads white; on the plateau.

Emilia sonchifolia (L.) DC. (Mulsevi)

A soft-pubescent herb of pasturelands, etc.; on the plateau.

Erigeron bonariensis L.

(*E. linifolius* Willd.; *Conyza ambigua* DC.)

An erect, sparsely branched herb of unweeded gardens; on the plateau.

Notonia grandiflora DC.

A robust shrub over 1 m tall, with yellowish heads; on the slopes, near rocks.

Siegesbeckia orientalis L.

A weed of wastelands near habitations.

Tridax procumbens L. (Vettukayachedi)

An abundant weed near cultivated places; throughout the range.

Vernonia cinerea (L.) Less.

A common weed; heads pink turning white; throughout the range.

Vicoa indica (Willd.) DC. (Mookkuthippondu)
In unweeded gardens; heads yellow; on the plateau.

MYRSINACEAE

Ardisia solanacea (Poir.) Roxb. (Manipudpam)
A large shrub with coriaceous, shining leaves; in the plateau forests.
Embelia basaal DC.
A large shrub with arching branches covered with numerous, large lenticels; on the plateau.

SAPOTACEAE

Madhuca longifolia (L.) Macbr. (Nattu Iluppai)
(*Bassia longifolia* L.)
A large and densely foliaceous tree over 40 m tall; on the plateau.

EBENACEAE

Diospyros ebenum Koenig
A medium-sized tree with woody fruits; in the plateau forests.
Diospyros ovalifolia Wt. (Vedukanari)
A small tree of the plateau forests.
Maba buxifolia Pers. (Kattuthovarai)
A shrub or small tree from half way up the ghats; one of the most abundant species of the plateau; occasional shrubs at the foothills.

OLEACEAE

Jasminum auriculatum Vahl (Udigai)
A climbing shrub with dense clusters of white, fragrant flowers; on the plateau.
Jasminum rigidum Zenk. (Oosimalligai)
In the forests of the slopes and of the plateau; flowers white.
Jasminum ? **trichotomum** Heyne
A woody straggler; flowers white; throughout the range.
Ligustrum perrottetii DC.
A large shrub with white flowers; on the plateau.
Ligustrum roxburghii C. B. Cl.
A shrub up to 5 m tall, with white flowers; on the plateau.
Linociera intermedia Wt. (Musiladi)
A tree with white, fragrant flowers; on the plateau.

APOCYNACEAE

Carissa spinarum L. (Sirukila)
A shrub with white flowers on the ziz-zag branches; one of the do-

minant species throughout the range.

Catharanthus pusillus (Murr.) Don (Milagaippoondu)
(*Vinca pusilla* Merr; *Lochnera pusilla* K. Schum.)
A glabrous annual herb with white flowers; in cultivated places on the plateau.

Catharanthus roseus (L.) Don (Kallaraippoo)
(*Vinca rosea* L.; *Lochnera rosea* Reichb.)
On the plateau; the white-flowered plants are far more numerous than the pink-flowered ones.

Ichnocarpus frutescens R. Br. (Manippilangodi)
A profusely branched, climbing shrub with rusty-tomentose branches; on the plateau.

Plumeria rubra forma **acuminata** Sant. & Irani ex Shah
(*P. acuminata* Ait.; *P. rubra* forma *acutifolia* (Ait.) Woods.)
Planted near a shrine on the plateau; petals white, with shades of yellow.

Wrightia tomentosa R. & S. (Tondampalai)
A small tree, tomentose on the younger branches; on the plateau.

Asclepiadaceae

Asclepias curassavica L.
Stray plants along a stream on the plateau.

Cosmostigma racemosum Wt. (Vattuvalli)
A climber with yellowish flowers; on the plateau.

Cryptolepis buchanani R. & S.
A profusely branched shrub with copious latex, yellowish flowers and green pods; on the plateau.

Cryptolepis grandiflora Wt.
A climber; on the slopes.

Cynanchum pauciflorum R. Br.
A climber; on the plateau.

Dregea volubilis (L.f.) Benth. ex Hook. f. (Kudasappalai)
(*Marsdenia volubilis* (L.f.) Cooke)
A woody climber with green flowers; on the plateau.

Gymnema hirsutum Wt. & Arn.
A climber with spirally twisted stems; on the plateau.

Gymnema sylvestre (Retz.) Schult. (Sirukurinji)
A woody climber; on the slopes.

Hemidesmus indicus (L.) Schult. (Nannari)
At the foothills; flowers yellow.

Sarcostemma acidum (Roxb.) Voigt (Kodikkalli)
(*S. brevistigma* Wt. & Arn.)
The succulent green branches seen in masses on thickets, etc.; flo-

wers noted only at the foothills, not above.

Secamone emetica R. Br. (Aatangodi; Angaravalli)

A well branched, wiry twiner in dense masses from a woody base; on the plateau.

? **Telosma pallida** (Roxb.) Craib.

A twiner with watery latex; on the plateau.

Toxocarpus kleinii Wt. & Arn.

A slender, villous, twiner with yellowish flowers.

LOGANIACEAE

Strychnos ? potatorum L.f. (Thethankottai)

A densely foliaceous tree with numerous fruit-like galls; on the plateau.

GENTIANACEAE

Exacum pedunculatum L.

A herb up to 15 cm tall; in moist ground; at the foothills.

BORAGINACEAE

Cordia evolutior Gamb.

A tree up to 6 m tall, with yellow drupes; on the slopes.

Cordia wallichii Don (Namavirai)

A tree up to 10 m tall; fruits yellowish; on the plateau.

Cynoglossum furcatum Wall.

A herb up to 1 m tall with bluish flowers on slender, elongate racemes.

Ehretia ? laevis Roxb. (Aadali)

A tree up to 10 m tall; flowers white; on the slopes and on the plateau.

CONVOLVULACEAE

Argyreia kleiniana (R. & S.) Raiz.

(*A. bracteata* Choisy)

A large climber noted for the showy, pink flowers and masses of persistent bracts; on the slopes and on the plateau.

Evolvulus alsinoides L. (Vishnukiranthi)

Common in open ground on the plateau.

Ipomoea obscura Ker.-Gawl. (Thalikodi)

A twining herb with delicate, yellowish corolla 1 cm across; on the slopes and on the plateau.

Ipomoea staphylina R. & S. (Ononkodi)

A massive climber with white flowers, dark purple in the tube; on

the slopes.

Rivea hypocrateriformis Choisy

A twiner on wayside thickets, etc.; at the foothills.

SOLANACEAE

Datura fastuosa L. (Oomathai)

Stems dark purple, somewhat succulent; in wastelands near habitations on the plateau.

Physalis peruviana L.

Plants found as new colonizers along the newly made ghat road.

Solanum giganteum Jacq.

A large shrub, white tomentose on the younger parts; flowers white; on the plateau.

Solanum khasianum Cl. var. **chatterjianum** Sengupta

A wayside subshrub; on the plateau.

Solanum nigrum L.

An annual herb with small, white flowers; on the plateau.

Solanum torvum Swartz (Sundai)

A shrub of open places on the plateau; flowers white.

Solanum verbascifolium L. (Malaichundai)

A large shrub or small tree, usually along fences; flowers white; on the plateau.

SCROPHULARIACEAE

Bacopa monnieri (L.) Penn. (Neerpirami)

(*Moniera cuneifolia* Michx.)

In marshy land on the plateau; flowers violet; opening by 9.30 a.m.

Ilysanthes oppositifolia Urban

In perennially moist ground on the plateau; flowers violet.

Limnophila ? rugosa (Roth.) Merr.

Notably robust specimens gregarious in marsh on the plateau; corolla purple.

Lindernia ciliata (Colsm.) Penn.

(*Ilysanthes serrata* Urban)

Abundant in marsh on the plateau; corolla purplish with a yellow blotch on the lower lip.

Lindernia crustacea (L.) F. Muell.

(*Vandellia crustacea* Benth.)

In pasturelands and unweeded gardens on the plateau.

Striga angustifolia (Don) Sald.

(*S. euphrasioides* (Vahl) Benth.)

Parasitic on *Pennisteum typoides;* flowers white; on the plateau.

Striga asiatica (L.) Kze.

Stray plants along the slopes; flowers white.

LENTIBULARIACEAE

Utricularia caerulea L.

In perennially moist ground; flowers purplish.

Utricularia ? graminifolia Vahl

On moist rocks along a stream on the plateau; flowers violet.

ACANTHACEAE

Andrographis alata (Vahl) Nees

An erect herb on the floor of the plateau forests; stems angular, almost winged at the apices.

Andrographis elongata T. And.

A herb with white corolla and purple stamens; at the foothills and on the slopes.

Asystasia gangetica T. And. (Meddaikkeerai)

A straggling and spreading herb along thickets, etc.; flowers purplish, on the plateau.

Barleria pilosa Wall.

An undershrub of the slopes with large crowded bracts.

Barleria prionitis L. (Kattu Kanagambaram)

An armed shrub with yellow flowers; very common along the ghats.

Dicliptera cuneata Nees

A branched herb with pink flowers; on the plateau.

Dipteracanthus prostratus (Poir.) Nees (Pottakanchi)

(*Ruellia prostrata* Poir.)

A diffuse, spreading subshrub with axillary flowers; corolla violet, falling off easily; on the plateau.

Ecbolium viride (Forsk.) Alst.

(*E. linneanum* Kurz)

A shrub with bluish flowers, and bracts purple along the margins; along the slopes.

Eranthemum capense L.

(*E. montanum* Roxb.)

A shrub up to 1 m tall, with blue flowers; on the plateau.

Justicia glauca Rottl.

A herb rather variable in size; flowers pink; on the slopes.

Justicia quinqueangularis Koen.

An undershrub with ascending branches; along bunds of paddy fields on the plateau.

Justicia simplex Don

A pubescent herb with small pink flowers; along the bunds of paddy fields on the plateau.

Phlebophyllum ? **versicolor** (Wt.) Brem.
(*Strobilanthes* ? *cuspidatus* T. And.)
A gregarious shrub over 1 m tall; leaves white, on the undersurface; flowers not seen; sparse on the slopes, abundant on the plateau.
Strobilanthes ? **micranthus** Wt. (Korakkuthazhai)
An erect shrub with leaves green throughout; flowers not seen; gregarious in patches in the plateau forests.
Thunbergia fragrans Roxb. var. **vestita** C. B. Cl.
A tomentose twiner with white flowers 3 cm across; on the plateau.

VERBENACEAE

Gmelina asiatica L. (Nilakkumil)
An erect shrub with golden yellow flowers; at the foothills.
Lantana camara var. **aculeata** (L.) Mold. (Arippu; Unni)
Only stray plants along the slopes; on the plateau it is almost non-existent in the forest, whereas it forms dense masses in the cleared areas; flowers pinkish; generally in fruit in July.
Lantana indica Roxb.
An erect shrub over 1 m tall with pinkish flowers; on the plateau.
Phyla nudiflora (L.) Greene (Poduthalai)
(*Lippia nodiflora* Mich.)
A prostrate herb rooting at the nodes; on the plateau in pasture-lands.
Premna corymbosa Rottl. & Willd. (Munnaikkeerai)
A shrub over 1 m tall with spreading branches; on the plateau.
Premna tomentosa Willd. (Podaganari)
A small tree, densely tomentose on the younger parts; on the plateau.
Stachytarpheta urticaefolia (Salisb.) Sims (Seemainayuruvi)
(*S. indica* Vahl)
Stray plants on the slopes, over 50 cm tall; abundant and gregarious in unweeded gardens on the plateau but the plants are smaller; flowers blue to purple; one of the most abundant weeds of the plateau.
Svensonia hyderabadensis (Walp.) Mold. (Naranjedi)
(*Bouchea hyderabadensis* Walp.)
Plants even up to 3 m tall, with pink flowers; at Masimalaiyanthittu, inside forests, on the plateau; said to be restricted in distribution.
Symphorema involucratum Roxb.
A shrub with arching branches; on the plateau.
Vitex altissima L. f. (Mayiladi)
A tree over 20 m tall, with violetish flowers; fairly common in the forests of the plateau.
Vitex negundo L. (Nochi)
A shrub with purple flowers; along streams, near villages, etc.; on the plateau.

Labiatae

Anisomeles indica (L.) Kze. (Vattapeimarutti)
Shrubby, over 1 m tall; at the foothills.

Leucas biflora R. Br. var. **procumbens** Gamb.
On the floor of the forests of the plateau; less on the slopes; flowers white.

Leucas lanata Benth.
Erect shrub with branches spreading to over 1 m; on the plateau, in thickets.

Leucas lavandulaefolia Rees
(*S. linifolia* Spr.)
An erect herb of wastelands; particularly abundant near cultivated places; on the plateau.

Ocimum adscendens Willd.
A branched herb; flowers with purple calyx and white corolla; along the slopes.

Orthosiphon glabratus Benth.
A branched herb; along the slopes.

Nyctaginaceae

Boerhaavia diffusa L. (Sattaranai)
Several procumbent branches from a stout rootstock; along the slopes.

Amaranthaceae

Amaranthus viridis L. (Kuppaikkeerai)
In wastelands near habitations; on the plateau.

Celosia argentea L. (Pannaikkeerai)
An erect herb up to 1 m tall, near cultivation; flowers pinkish; on the plateau.

Chenopodiaceae

Basella rubra L. (Sirupasali)
A glabrous, succulent twiner, with reddish spicate inflorescence; on the plateau.

Chenopodium ambrosioides L.
In wastelands near habitations; plants strongly scented; on the plateau.

Aristolochiaceae

Aristolochia indica L. (Isuramuli)

A perennial twiner; perianth with shades of yellow and green, tinged purple; on the plateau.

PIPERACEAE

Peperomia dindigulensis Miq.

A succulent herb with pinkish stems; on moist rocks in the shade, on the plateau.

Piper attenuatum Buch.-Ham.

On the plateau.

LAURACEAE

Cassytha filiformis L. (Erumaikkottam)

At the foothills; parasitic, without any host specificity.

Cinnamomum ? **iners** Reinw.

A tree with large, coriaceous, shining leaves; on the plateau.

Litsaea deccanensis Gamb.

A tree with grey branches and rusty tomentose buds; on the plateau.

ELAEAGNACEAE

Elaeagnus indica Ser.

A straggler with arching branches; undersurface of leaves white-tomentose; common, even abundant, in and around the forests on the plateau.

LORANTHACEAE

Dendrophthoe falcata (L. f.) Etting (Pulluruvi)

(*Loranthus longiflorus* Desv. var. *falcatus* Kurz)

A densely branched parasite with yellow perianth and reddish stamens; at the foothills; on a variety of hosts.

Helicanthus elastica (Desr.) Danser (Andagan)

(*Loranthus elasticus* Desv.)

Perianth white at the base, green on the lobes; filaments red; on the plateau.

Loranthus ? **courtallensis** Gamb.

On the plateau.

Loranthus ? **recurvus** Wall.

On the plateau.

Scurrula cordifolia (Wall.) Don

(*Loranthus cordifolius* Wall.)

A massive parasite with rusty-tomentose foliage and orange-yellow flowers with short perianth tube; on the plateau.

Viscum orientale Willd.

On the plateau; no host specificity.

Viscum ramosissimum Wall. (Ottu)

Parasitic on *Dendrophthoe falcata* itself parasitic on *Zizyphus;* at the foothills.

SANTALACEAE

Santalum album L. (Santhanam)

The most important source of forest revenue from the district, the bulk of which comes from the Pacchaimalais; several trees are affected by the "spike" disease; throughout the range.

EUPHORBIACEAE

Acalypha fruticosa Forsk. (Chinni)

A well branched shrub; along the slopes.

Antidesma zeylanicum Lamk. (Nolaidali)

A tree up to 8 m tall, with the tender parts rusty-tomentose, and fruits red.

Bridelia roxburghiana Gehrm.

A tree of the plateau forests.

Cleistanthus collinus (Roxb.) Benth. ex Hook. f. (Oduvan)

A large shrub or small tree up to 5 m tall with capsules up to 3 cm across; one morsel of ground leaves or the rind of the capsules said to be lethal; said to be used for suicide by the hill tribes; throughout the range.

Dalechampia indica Wt.

A twiner with large bracts and glandular calyx; on the slopes.

Emblica officinalis Gaertn. (Nellikkaimaram)

Occasional trees on the plateau; fruits few.

Euphorbia hirta L. (Ammanpaccharisi)

In the pasturelands; throughout the range.

Givotia rottleriformis Griff. (Boothalai)

A tree over 20 m tall; leaves densely white tomentose on the under-surface; fruits with a hard shell, covered with fluffy tomentum; on the slopes.

Jatropha curcas L. (Kattamanakku)

Along hedges; throughout the range.

Kirganelia reticulata (Poir.) Baill. (Neerpalai)

A shrub, usually near streams; on the plateau.

Mallotus philippinensis (Lamk.) Muell.-Arg. (Kapilapodi)

In dense groups in cleared lands where it seems to be a colonizer; on the plateau.

Melanthesa turbinata (Koen. ex Roxb.) Oken

(*Brevnia patens* Rolfe)

A shrub over 1 m tall; on the plateau.

Phyllanthus fraternus Webster (Keezhanelli)

(*P. niruri* auct., non L.)

A delicate herb in wastelands; throughout the range.

Phyllanthus gardnerianus Baill.

Several branches from a woody rootstock; in pasturelands on the plateau.

Phyllanthus maderaspatensis L.

A decumbent herb; at the foothills.

Phyllanthus polyphyllus Willd. (Keelanelli)

A tree resembling *Emblica officinalis* in habit; on the plateau.

Phyllanthus urinaria L. (Shivappunelli)

A herb with creeping branches; leaves and fruits reddish; on the plateau.

Sebastiania chamaelea Muell.-Arg.

A weed of pasturelands; fruits reddish.

Securinega virosa (Roxb. ex Willd.) Pax & Hoffm. (Pula; Veppulathi)

(*Fluggea virosa* Baill.)

A large shrub with minute flowers; on the plateau.

Tragia involucrata L. (Canchori)

A twiner with stinging bristles; on the plateau.

ULMACEAE

Celtis wightii Planch. (Vellaithovarai)

A densely foliaceous tree up to 10 m tall, with solitary fruits; on the slopes and on the plateau.

Holoptelea intergrifolia (Roxb.) Planch. (Aavili)

A tree up to 12 m tall; on the plateau.

Trema orientalis (L.) Bl. (Amparuthi)

A tree of the plateau forest borders.

MORACEAE

Artocarpus heterophyllus Lamk. (Pila)

(*A. integrifolia* L.)

Found in cultivation, and probably also wild.

Ficus benghalensis L. (Aalamaram)

Occasional trees throughout the range.

Ficus hispida L. f. (Peiyathi)

A tree up to 10 m tall, without aerial roots; tender parts hispid; throughout the range.

Ficus ? luscens Bl. (Malai Ichi)

(*F. ? infectoria* Roxb.)

A large tree over 30 m tall, with heavy, horizontal branches; near

habitations, on the plateau.

Ficus mysorensis Heyne (Kal Aal)

A large tree with copious foliage; on the plateau.

Plecospermum spinosum Trec. (Koratti)

A large shrub with numerous arching branches, with conspicuous thorns all over; on the slopes and on the plateau.

Streblus asper Lour. (Parungu; Piramaram)

A large shrub or small tree; on the plateau; said to be locally used for decorations on festive occasions.

Streblus taxoides (Heyne ex Roth.) Kurz

(*Phyllochlamys spinosa* Bur.)

An armed shrub up to 3 m tall; very abundant in the forests of the plateau.

Gnetaceae

Gnetum ual Brongn. (Karunjaraikkodi)

Fairly common in the forests of the plateau; the vernacular name refers to the use of the stems as ropes.

Orchidaceae

Cymbidium aloifolium Sw.

Epiphytic; flowers brownish red; on the plateau.

Eulophia epidendracea Fischer

Terrestrial; perianth green but for the white lip; on the slopes.

Habenaria plantaginea Lindl.

Terrestrial; leaves 3-4, spreading on the ground; flowers white; in moist, shady ground on the plateau.

Habenaria viridiflora R. Br.

In marshy ground; flowers green; on the plateau.

Hetaeria ? ovalifolia Benth.

Terrestrial; abundant in moist, shady places, in humus; on the plateau.

Vanda parviflora Lindl.

Epiphytic; on the plateau.

Vanda spathulata Spreng.

Usually terrestrial initially, but epiphytic later; shoots showing up conspicuously above the thickets, especially during flowering; on the plateau.

Hypoxidaceae

Curculigo orchioides Gaertn. (Nilappanai Kizhangu)

An acaulescent, ground herb with bright yellow flowers; very abundant in pasturelands on the plateau.

Dioscoreaceae

Dioscorea ? esculenta Burk. (Musilamvalli Kizhangu)

A climber from a tuberous rootstock, found all over the plateau; the rhizomes are eaten, even raw, by the local people.

Liliaceae

Asparagus ? racemosus Willd. (Seemai Sadaveri)

On the plateau.

Gloriosa superba L. (Kalappai Kizhangu)

Throughout the range; not too common.

Sansevieria roxburghiana Schult. f. (Marul)

Acaulescent; rootstock creeping; flowers white, along a scape up to 1 m tall; at the foothills.

Scilla hyacinthina (Roth.) Macbr. (Sirunari Vengayam)

(*S. indica* Baker)

A scapigerous herb with tunicate bulbs and leaves with black blotches; flowers purple; at the foothills.

Smilax zeylanica L. (Malaithamarai)

On the plateau.

Pontederiaceae

Monochoria vaginalis Presl.

In marsh, paddy fields, etc.; flowers blue; on the plateau.

Commelinaceae

Commelina benghalensis L. (Kanavazhai)

In shady places, along the bunds of paddy fields, etc.; perianth blue; on the plateau.

Commelina paludosa Bl.

(*C. obliqua* Ham.)

The uniformly white perianth seems to be characteristic of the plateau.

Commelina paleata Hassk.

On the plateau; perianth blue.

Typhaceae

Typha angustata Bory & Chaub. (Jambu)

Plants stunted, scarcely exceeding 1 m tall; along a rivulet at Sobanapuram, at the foothills.

Araceae

Acorus calamus L. (Vasambu)

Gregarious in marsh at Sembur, on the plateau.

Colocasia esculenta (L.) Schott.

(*C. antiquorum* Schott.)

Gregarious, in marsh; petioles dark purple; leaves up to 50 × 50 cm; spathe yellow.

Cyperaceae

Bulbostylis barbata Kunth

On the slopes.

Cyperus eleusinoides Kunth

Robust plants in marsh on the plateau.

Cyperus haspan L.

Culms even over 1 m tall; in stagnant water on the plateau.

Cyperus sanguinolentus Nees

In marshy land; spikelets green; on the plateau.

Fimbristylis bisumbellata Bub.

In marshy ground; on the plateau.

Fimbristylis dichotoma Vahl

On the plateau, in marshy land.

Fimbristylis miliacea Vahl

On the plateau, in marshy land.

Fimbristylis spathacea Roth.

On the plateau.

Fimbristylis tetragona R. Br.

Culms ash-coloured, in dense clusters in marshy ground; on the plateau.

Kyllinga sp.

Along the bunds of paddy fields; on the plateau.

Pycreus globosus Reichb.

On the plateau in wastelands.

Pycreus puncticulatus Nees

On the plateau.

Scirpus erectus Poir.

Gregarious in marshy places on the plateau.

Gramineae

Apluda mutica L.

(*A. aristata* L.)

Culms exceeding 1 m tall, scrambling along thickets; on the plateau.

Arachne racemosa (Heyne) Ohwi

(*Eleusine verticillata* Roxb.)

Robust specimens along the freshly cut ghat road.

Aristida depressa Retz.

Robust specimens along the freshly cut ghat road.

Bambusa arundinacea (Retz.) Willd. (Perumungil)
On the slopes; young culms yellow.

Brachiaria ramosa (L.) Stapf (Puliampullu)
Along the slopes.

Chrysopogon fulvus (Spreng.) Chiov. (Cholappullu)
(*C. montanus* Trin.)
At the foothills; spikelets with conspicuous yellow anthers.

Eleusine corocana (L.) Gaertn. (Kael Varagu)
An escape from cultivation; along the freshly cut ghat road.

Eragrostiella bifaria (Vahl) Bor (Shernaipullu)
(*Eragrostis bifaria* Wt. ex Steud.)
At the foothills, in open ground.

Eragrostis tenella (L.) Beauv. ex R. & S.
[*E. plumosa* (Retz.) Link]
On the plateau.

Eragrostis unioloides (Retz.) Nees ex Steud.
In marshy ground; spikelets purple.

Hackelochloa granularis (L.) Kze
On the plateau; cultivated.

Heteropogon contortus (L.) Beauv. ex R. & S. (Oosippullu)
At the foothills.

Panicum repens L. (Injippullu)
In moist ground, along bunds of paddy fields, etc.; on the plateau.

Perotis indica (L.) Kze
At the foothills; recognized by the long, purple, feathery awns.

Setaria verticillata (L.) Beauv.
Along the freshly cut ghat road.

Themeda cymbaria Hack. (Sadumpullu)
Culms robust, over 2 m tall where ungrazed; a good fodder.

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Biology and fishery of *Pseudosciaena sina* (C.) at Ratnagiri, South Maharashtra[1]

B. V. Bhusari[2]

(With five text-figures)

Sciaenids constitute 3 per cent of the total marine catch in India contributing nearly 26,000 m tonnes per annum (on average for 10 years). In Maharashtra the percentage of sciaenids is 4.6 per cent (9,111 m tonnes) (on average for 10 years) per annum on total marine catch and 35 per cent of the total sciaenid catch of India.

Ratnagiri is an important fishing centre in southern Maharashtra and sciaenids contribute nearly 22 per cent of the total trawl catch. Fourteen species of sciaenids have been recorded, and among these *Pseudosciaena sina* predominates, contributing nearly 38.5 per cent to the total trawl catch.

Material and methods

Fishes required for the purpose of this study were collected regularly from the trawl catches landed at Ratnagiri. The trawlers operate in an area (arc) about 20 miles north and south of Ratnagiri and land their catches at different landing centres in Ratnagiri, i.e. Kalbadevi, Mirkarwada and Rajiwada. As the trawling and shore seine operations are suspended during the monsoon season specimens were obtained from the catches of cast nets and hook and line, brought to Ratnagiri fish market. In all 600 specimens were measured to the nearest millimetre and weighed to the nearest gramme. For the study of food and feeding habits the specimens were cut open and measurements of the component parts of the alimentary canal were taken. The relative length of intestine (RLI) and relative length of the gut (RLG) were noted. Qualitative analysis of food was done in both adults and juveniles whereas the quantitative analysis of food items was done by displacement method for the adults only.

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For determining the minimum size of maturity in the female fifty specimens were examined. As the sexes cannot be distinguished in sizes below 7 cm, fishes of 8 cm and above only were examined for the different maturity stages in females. The colour of the ovary and its extension in the body cavity were taken into consideration for measurements of ova diameter. Ovaries were preserved in 5 per cent formalin for 8-10 days. About 700 ova were measured from each ovary. The ova were separated by testing out a portion of the posterior region of the ovary on a glass slide and were measured by means of eyepiece micrometer.

Ova measuring less than 5 md (1 md = 0.03 mm) were not considered as these were present in the ovaries in all stages of maturity (De Jong 1939, Clark 1934). Fecundity was estimated by weighing one gram sample of the ovary and counting the number of eggs contained in it. The number of eggs in the ovary was computed by taking into consideration the total weight of the ovary. The maturity scale adapted by ICES (Wood 1930) was followed for studying the progression of ova towards maturity. The spawning in this species was determined by studying the different stages of the ovary occurring in each month. The percentage of occurrence of males and females was observed for the sex ratio.

The fishery of the species was estimated from random samples of *c* 10 kg once every ten days for analysis. For studying the length frequency distribution, 1500 specimens were measured within a period of 3 months.

Food and feeding habits

Earlier works [Gopinath (1942), Mookerjee *et al.* (1946), Chacko (1949), Kow (1950), Jacob (1948) and Rao (1964)] indicate that adult sciaenids consume a variety of food consisting mainly of crustaceans, fishes, molluscs, polychaetes and echinoderms and are thus carnivorous and benthic. During this investigation it was found that juveniles ranging in total length from 5.6 to 7 cm mainly feed on planktonic copepods, *Lucifer, Mysis, Acetes,* small prawns and polychaetae larvae.

The following items of food were seen in the gut contents of ***Pseudosciaena sina***—

1) Teleosts — Sole fish, *Leognathus* sp., young of sciaenids.
2) Crustaceans — *Penaeus* sp., *Metapenaeus* sp., crustacean larvae, crabs, *Mysis, Squilla,* hermit crabs and Amphipods.
3) Echinoderms — Sea urchins.
4) Polychaetes — Nereid worms.
5) Molluscs — Bivalves.

Fluctuations in the composition of the main food items consumed by adults of *Pseudosciaena sina* in different months are shown in table 1.

It will be seen from table 1 that crustaceans form the most do-

TABLE 1

PERCENTAGE COMPOSITION OF IMPORTANT FOOD ITEMS DURING DIFFERENT MONTHS IN THE YEAR AUGUST 1962 TO JULY 1963 IN *Pseudosciaena sina*

Months	No. of specimens examined	Fishes	Prawns	*Squilla*	*Acetes*	Other crusta-ceans	Total crusta-ceans	Salps	Poly-chaetes	Molluscs	Misc.
1. August 1962	60	6.95	48.10	—	41.87	3.12	93.09	—	—	—	—
2. September	86	6.70	30.02	3.63	18.55	40.18	92.38	—	—	0.92	—
3. October	33	15.62	56.25	12.50	7.80	3.12	79.65	—	—	—	4.68
4. November	31	33.35	27.87	36.36	2.42	—	66.65	—	—	—	—
5. December	44	28.55	23.27	49.87	—	—	73.14	—	—	—	—
6. January 1963	29	26.66	36.65	33.32	—	—	69.97	3.33	—	—	—
7. February	29	70.00	30.00	—	—	—	30.00	—	—	—	—
8. March	72	5.55	18.03	65.21	—	1.38	84.61	6.93	—	2.76	—
9. April	23	—	8.16	86.00	—	—	94.16	—	—	6.00	—
10. May	35	3.93	35.43	3.93	25.19	—	64.05	—	—	—	31.49
11. June	17	7.40	25.90	25.90	40.70	—	92.50	—	—	—	—
12. July	24	17.77	17.77	17.77	13.33	33.30	82.17	—	—	—	—

minant group as its food. Among crustaceans, prawns, *Squilla, Acetes* are the most common items.

Prawns: Prawns are taken practically throughout the year. The percentage of prawns as food in the gut contents varies from 8.16 to 56.25. The average percentage of prawns in August, September and October was 45. The percentage of prawns during these three months in the fishery is also high and its average percentage is 70 during this period.

Squilla: *Squilla* in the food was observed during whole year except in the months of August and February. The percentage of *Squilla* in the food was observed to be more in the month of December (50%), March (65%) and was maximum in the month of April (86%).

Fish: This is the third important item. Fish as food was observed throughout the year with maximum in February (70%) and minimum in May (3.93%). The average percentage of fish in food in the months of November, December, January and February was 40.

Acetes: *Acetes* was commonly observed from May to November in food. Maximum percentage was in June (41%) and August (42%) whereas it was minimum in November (2.42%).

The absence of *Acetes* in food from December to April in spite of their presence in the locality and availability indicates that the fish prefers prawns, *Squilla* and fish. The presence of benthic animals like prawns, *Squilla,* molluscs, crabs in the gut contents indicates its bottom feeding habits.

Maturation and Spawning

Description of the ovary

Until the fish attains 7 cm in total length it is difficult to distinguish females from males. The gonads in both the sexes are threadlike and whitish in colour. The ovaries in specimens over 7 cm appear slightly swollen compared to testes of corresponding size. Different stages of ovarian maturity as determined from external appearance of the ovary and its extension in relation to the body are given below:

1) Immature Ovary — The ovary is transparent with reddish appearance and extends to about $\frac{1}{2}$ of the body cavity.

2) Maturing Ovary — The ovary is yellowish in colour. The ova are granular in nature and are also visible to the naked eye. The ovary extends to nearly $\frac{3}{4}$ of body cavity.

3) Mature Ovary — The ovary is similar in appearance to the maturing ovary but is more swollen and extends the entire length of the body cavity.

4) Ripe Ovary — The ovary at this stage is fully swollen occupying the entire body cavity. Ova are transparent.

5) Spent Ovary — The ovary is flaccid, blood-shot and wrinkled and extends ½ of the body cavity or more.

Size at first maturity

To study the minimum size of maturity in the females a number of specimens were examined. As already stated sexes are not clearly distinguishable below 7 cm and, as such specimens ranging from 8 to 14 cm were only considered. From the data plotted in Fig. 1, it will be seen that 15 per cent of the fish matured in the 11.2 cm groups, and 48 per cent in the 12.5 cm groups. Nearly 50 per cent of the females of *Pseudosciaena sina* reached first maturity at a length of 11.2 to 12.5 cm. This is, therefore, considered as the minimum size of first maturity. The fishes measuring 13 cm and above were 100 per cent mature.

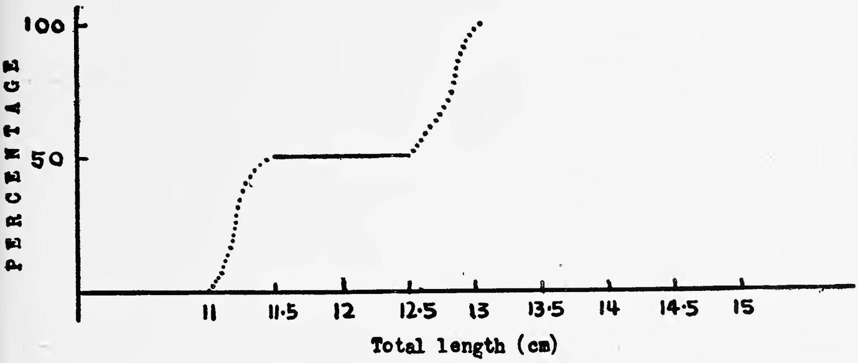

Fig. 1. Size at first maturity in *Pseudosciaena sina.*

Development of Ova

An ovary in advanced maturity was selected for studying the maturation stages of the ova. A sample of ova from this ovary was taken and ova diameter measurements were made. The ova were classified in micrometer division groups and a percentage frequency polygon was drawn.

First batch

Ova ranging in size from 0 to 5 m d. in diameter. The ova are transparent and the nucleus is clearly visible. Such ova are present throughout the year and represent the general stock of eggs.

Second batch

Diameter 6 to 10 m.d. These ova are also transparent with nucleus and protoplasmic layer visible.

Third batch

Diameter 11 to 15 m d. Ova granular and yellow in colour and with yolk.

Fourth batch

Diameter 16 to 20 m d. Ova granular, round, and yellow in colour.

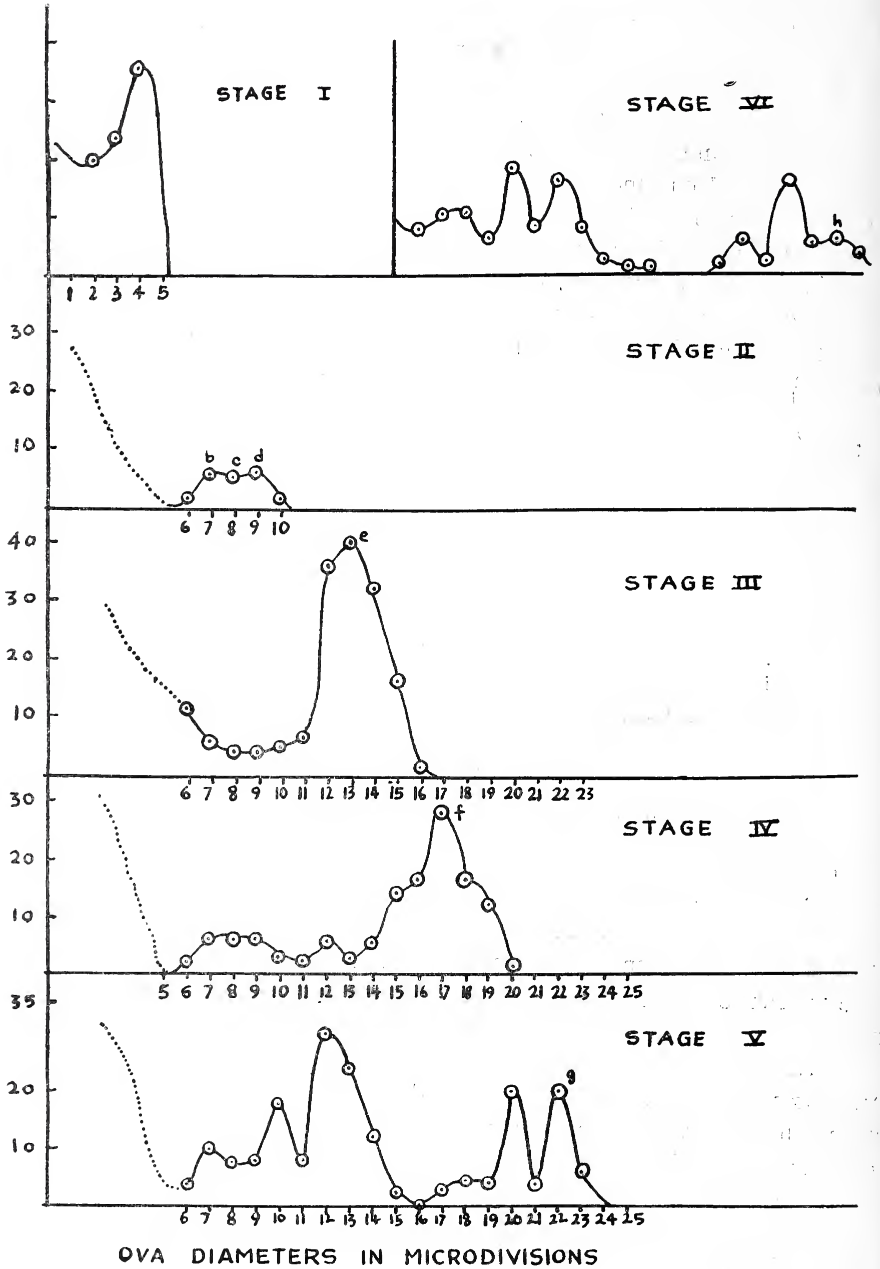

Fig. 2. Different stages of Maturation in *Pseudosciaena sina*.

Fifth batch

Diameter 21 to 25 m d. Ova round and transparent with a single oil globule. This is perhaps the spawning stage of the ovary.

To determine the growth of the ovary from immature to spent stage, it is necessary to arrange the data in chronological order starting from the month in which immature ovaries are observed until the period when spent ovaries occur.

However, when the observations on the condition of the ovary were undertaken, it was found that fish in different stages of maturity occurred in any sample indicating that all the fish do not mature simultaneously. It was, therefore, decided to group the data on the basis of largest mode in diameter frequency percentage of ova.

Accordingly, a number of fishes in different stages of maturity were selected and ova diameter measurements were made. They are represented by frequency polygins (Fig. 2). In all 10 stages of maturity were encountered. They are:

1) *Immature*
   i) Stage "a" frequencies with a mode at 3 m d.
   ii) Stage "b" frequencies with a mode at 5 m d.
2) *Maturing*
   iii) Stage "c" frequencies with a last mode at 7 m d.
   iv) Stage "d" frequencies with a last mode at 10 m d.
   v) Stage "e" frequencies with a last mode at 12 m d.
   vi) Stage "f" frequencies with a last mode at 15 m d.
3) *Mature*
   vii) Stage "g" frequencies with a last mode at 17 m d.
   viii) Stage "h" frequencies with a last mode at 20 m d.
4) *Ripe*
   ix) Stage "i" frequencies with a last mode at 25 m d.
5) *Spent*
   x) Stage "j" frequencies with a last mode at 5 m d.

More than seven stages of maturity could be described in *Pseudosciaena sina* but as per standards of the International Council of exploration of Sea (Wood 1930) the stages examined are:

Stages in *Pseudosciaena sina*	Ova diameter range in m d.	Stages described by I.C.E.S.
Stage "a" & "b"	0 to 5	I
Stage "c" & "d"	5 to 10	II
Stage "e" & "f"	10 to 15	III
Stage "g"	15 to 17	IV
Stage "h"	17 to 20	V
Stage "i"	20 to 25	VI (Spawning)
Stage "j"	Less than 6	VII (Spent)

Fishes with ovaries in all these stages of maturity were observed nearly throughout the year.

However, to study the spawning season, the data from 400 specimens were converted into frequency percentage of stages of maturity for each month (Fig. 3).

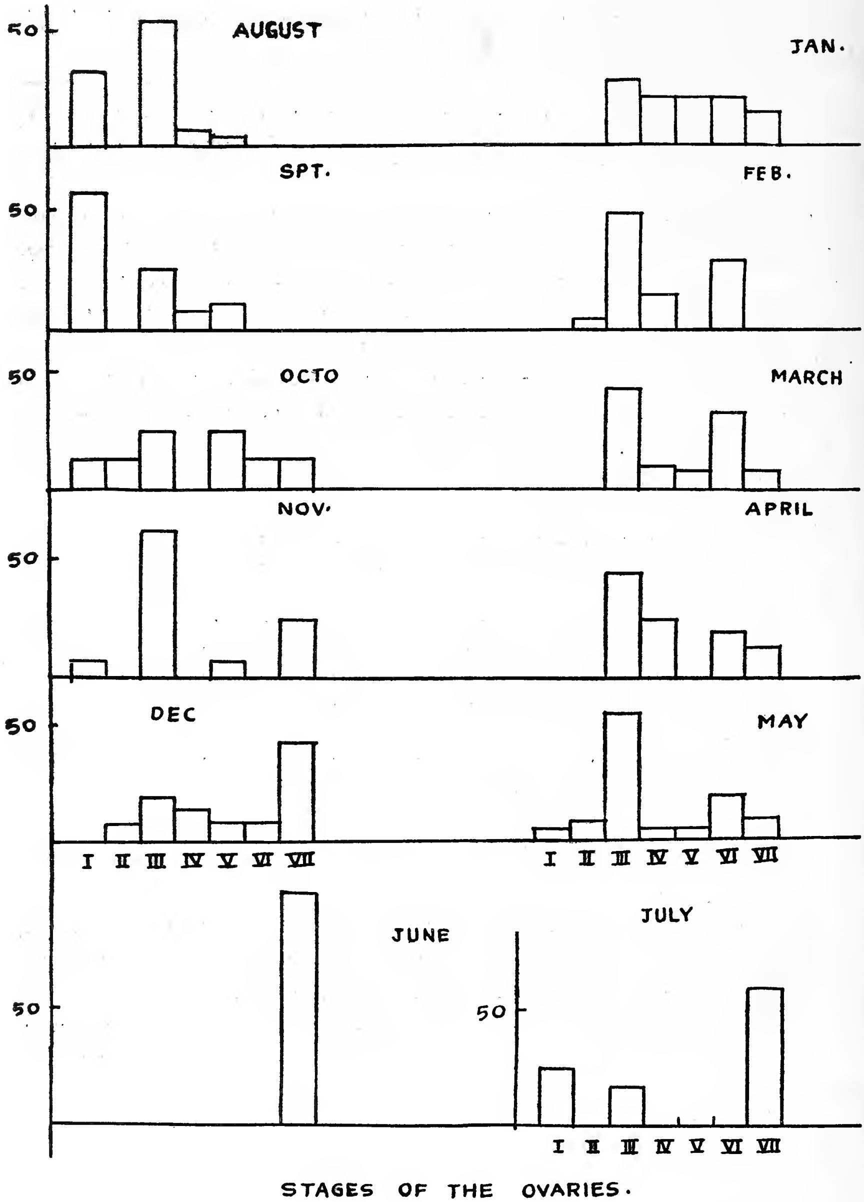

Fig. 3. Percentages of different stages of maturity in *Pseudosciaena sina* in different months.

From the histograms it is seen that fishes in stages III, IV and V of maturity are very common, forming 50 to 80 per cent. During the study period few fishes in stage VI of maturity were observed.

There is no information on the eggs and larvae of *Pseudosciaena sina*. Attempts to collect these were also not successful. In the absence of any information on eggs and larvae it is difficult to fix up a definite spawning period. The fishes in stages IV and VI of maturity are available from October to May, and fish in spent condition (VII stage) from October to July. Nearly 85 per cent spent ovaries were encountered in the months of June and July.

Frequency of spawning

The multiplicity of modes in the ova diameter frequency curves shows that the size range of ova is large and there is a continuous gradation, indicating several batches of eggs in all stages of maturity. Thus, it appears that the production and withdrawal of eggs is a continuous process and the species spawns more than once over a greater part of the year. The presence of fish in advance states of maturity IV, V, VI and spent individuals over a greater part of the year seems to corraborate this inference. The availability of these fishes in large quantities in trawl catches at Ratnagiri also supports the above findings.

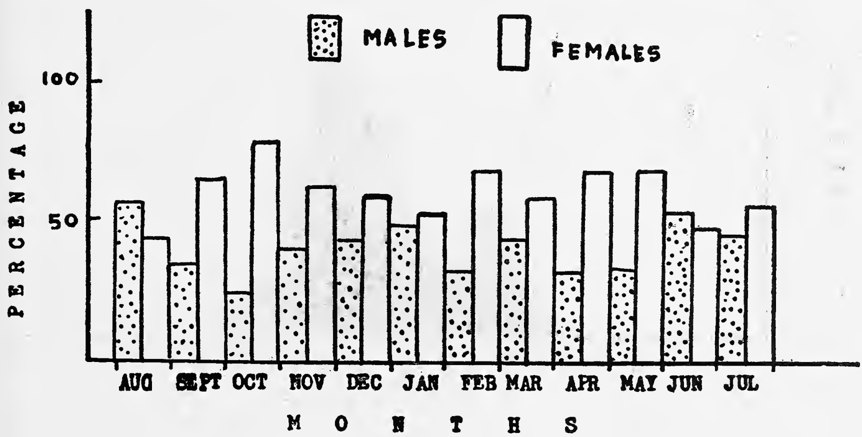

Fig. 4. Percentage of occurrence of Males and Females.

Fecundity

The ova count of this species shows that ova produced by individuals of the same length showed variation. The fecundity varies between 32,174 to 60,840 eggs.

	Weight of the ovary in gm	No. of eggs
i)	9.420	60,840
ii)	6.900	47,140
iii)	5.530	46,610
iv)	4.640	40,620
v)	2.550	32,174

Since specimens of the same length show variation, it is probable that there is a prolonged spawning period, and that the spawning is intermittent and that the eggs are spawned in batches.

Sex Ratio

From Fig. 4 it is evident that the female of *Pseudosciaena sina* predominates in the commercial catches throughout the year.

Fishery

As already stated, the trawl catch landings of sciaenids, the *Otolithus* and *Pseudosciaena sina* together contribute nearly 83 per cent of the total sciaenid catch at Ratnagiri. To analyse the length frequency distribution 1,500 specimens were measured at random for a period of three months, i.e. October, November and December, when fishing season is in full swing at Ratnagiri. The catch analysis shows (Fig. 5)

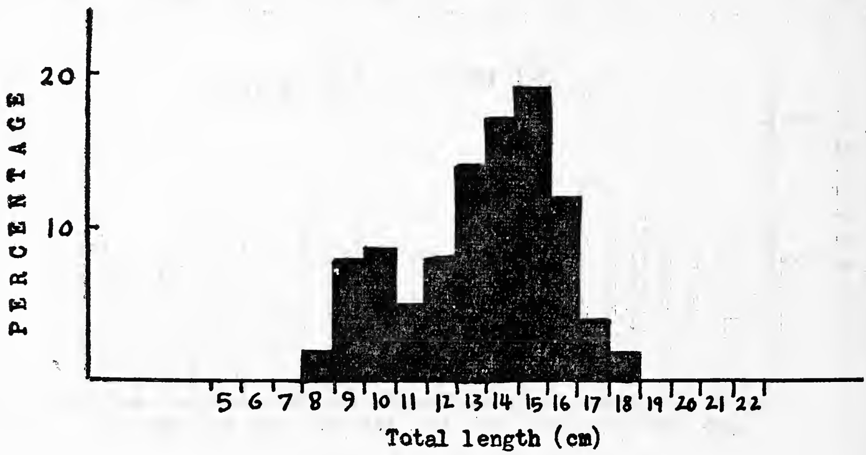

Fig. 5. Length frequency distribution in *Pseudosciaena sina.*

that fishes ranging in size from 12-13 cm in total length are most common and dominant in the trawl catches and form the major group in the fishery at Ratnagiri . It has been observed that these fish mature for the first time at this length and are caught in trawl without giving any chance to spawn even for the first time; probably this is detrimental to the sustained yield of sciaenid fishery. Attention should be drawn to the fact that the catches of sciaenids have been going down during the last ten years. Vellappan Nair *et al.* (1969) found the average annual landing of sciaenid catches in India to be 36,320 M. tonnes (1950-1962)

whereas the 1962-1971, average is 26,000 M. tonnes and that of Maharashtra 13,570 M. tonnes (1960-62) and 9,111 M. tonnes (1962-71).

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Studies on Indian Crickets (Orthoptera: Insecta), Part – III[1]

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(*With eighteen text-figures*)

This paper deals with 13 species of Indian Crickets comprising of six genera of the subfamily Gryllinae, of which *Gryllopsis rajasthanensis* Bhowmik, female of *Turanogryllus dehradurensis* Bhowmik, immature stages of *Turanogryllus rufoniger* (Chopard), and male genitalia of *Stephoblemmus humbertiellus* Saussure (which is also a new record from India) and of *Coiblemmus compactus* (Chopard); *Gryllopsis jammuensis* Bhowmik (1967) has been described and transferred to the genus *Turanogryllus*.

INTRODUCTION

This paper is the third in the series on Indian Crickets (Gryllidae) and is a portion of the unpublished material of the thesis submitted for the award of doctorate degree of the Calcutta University. Additional information on the morphology, abundance and nomenclatural changes of 13 species belonging to the subfamily Gryllinae are described. In order to avoid duplication in respect to references etc. only those which have been omitted by Chopard (1969) are included here.

Genus *Gryllopsis* Chopard, 1928

Gryllopsis Chopard, 1928, *Rec. Ind. Mus. 30*:13.

Diagnosis: The genus is characterized by large rounded head and nearly cylindrical body; usually perfectly developed, very wide elytra in males; females may be apterous or may bear very short elytra which sometimes may be reduced to only pads; internal tympanum absent on anterior tibia; subgenital plate with conical or rounded apices; absence of styliform process in male genitalia.

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Remarks: The genus *Gryllopsis* had been thought so far as one of the very widely distributed genera of oriental crickets. But recent studies based on male genitalia show that this genus and the genus *Turanogryllus* Tarbinskii (1940) though they have in common many morphological characters are readily distinguishable from each other by the presence or absence of styliform process in the male genitalia. It is found that quite a few species described previously as *Gryllopsis* possess styliform process in the genital structures like those of *Turanogryllus.* In the fitness of things those *Gryllopsis* possessing styli in genitalia, *inter alia,* are transferred to the latter genus.

Gryllopsis furcata (Saussure)

1877. *Gryllodes furcatus* Saussure, *Me'm. Soc. phys. Hist. nat. Geneve,* 25: 399-400.

Additional characters: FEMALE: Apterous, testaceous brown or rufous brown, pubescent insect with very stout cylindrical body. Head spherically convex, the pale lines on occiput and vertex usually very obscure; in rare exceptions they have four distinct testaceous light lines (specimen from Mysore); arched posterior band about thrice as wide as anterior band, connects the eyes and is brown or dark brown; anterior band also arched and connects only the antennal sockets; frontal rostrum about four times as wide as the first antennal segment; facial shield prominent, convex and with a median suture; clypeofrontal suture almost straight. Pronotum transverse and so convex that it appears saddle shaped, both anterior and posterior margins straight but sides parallel; lateral lobes square shaped, the inferior margin being horizontal. Ovipositor large, strong, shorter than posterior femora, apical valves with acute apices but the superior valves are longer than their corresponding inferior valves. The valves remain wide open at rest. Subgenital plate with truncated apex. Anterior tibia with an oval, elongated tympanum at external face only. Posterior femur very stout and wide, rufous brown, striations on it hardly recognizable but knee is distinctly dark brown; posterior tibia with variable number of spines, usually the inner ridges with four or five spines and the external ridges with five to six spines but specimens from Mysore show four external and five internal spines in both sexes; supero-internal spurs almost subequal to the intermediate internal spurs; posterior metatarsi with four to five internal and four to six external denticles on each margin.

MALE: Differs from female in having well developed brownish or dark brown elytra with three oblique veins extending up to about two-thirds of abdomen; diagonal vein short, straight and biforked at base; mirror much obliquely disposed, wider than long, divided by a curved vein and united with the first chord by a veinlet; apical field very short,

usually with three much obliquely disposed veins and a false vein and with distinct but irregular areolae; triangle intercale distinguishable; anal vein almost broken at right angle, and the scantly reticulated field with five regularly spaced, feebly curved veins; mediastinal vein with one branch only.

Measurements (in mm): Male: Length of body 16.25-17; length of pronotum 4.25-4.55; width of pronotum 5.25-5.5; elytra 6.75-8; posterior femora 11.5-12; posterior tibiae 8-8.75.

Female: Length of body 16.25-20; length of pronotum 4.75-5; width of pronotum 5.25-6.25; posterior femora 14-15.75; posterior tibiae 9.9-10.5; ovipositor 7-14.25.

Material examined: 1 male, 1 female from Mysore city; 1 female from Coimbatore; 2 females from Rajpur (Dehra Dun); 2 males, 2 females from Nagarjunkonda (Andhra Pradesh).

Remarks: This species can easily be distinguished from all other species of the genus by its strongly cylindrical body, besides its rounded head with two transverse bands and open type of ovipositor.

Gryllopsis rajasthanensis Bhowmik (Figs. 1 & 2)

1967. *Gryllopsis rajasthanensis* Bhowmik, *Proc. Ind. Sci. Cong. Assoc.* Benaras, Part B: 491.

Description: FEMALE: Small, body cylindrical, yellowish and densely pubescent. Head as wide as the pronotum in front, yellowish, with two transverse brown bands and of these anterior one connects the bases of antennal sockets and the posterior one the inter-ocular sockets; occiput and vertex with five very indistinct longitudinal brownish lines. Lateral ocelli brownish, anterior ocellus very small and yellowish. Frontal rostrum almost twice as wide as the first antennal segment and parallel sided. Labrum broad, rounded at apex and partially trilobed; clypeus partially divided by a median longitudinal suture; clypeofrontal suture strongly arcuate. Eyes black, very prominent and oval. Pronotum pale yellowish and transverse, anterior margin being slightly concave and posterior margin nearly straight, both margins ciliated, sides a little convex at the middle; disc convex, densely pubescent, with a median longitudinal suture and two triangular lobes brown, rest yellowish, inferior margins ascending posteriorly. Abdomen yellowish but mottled with brownish spots on dorsum. Ovipositor yellow, straight, long, apical valves acute. Legs yellow. Anterior tibia with a long oval tympanum at its external face only. Posterior femora very stout, longer than abdomen, indistinctly striated at external face; posterior tibia with four external and five internal spines; posterior metatarsi with seven external and five internal brownish denticles.

Elytra extending up to the middle of abdomen, yellow, these overlap on

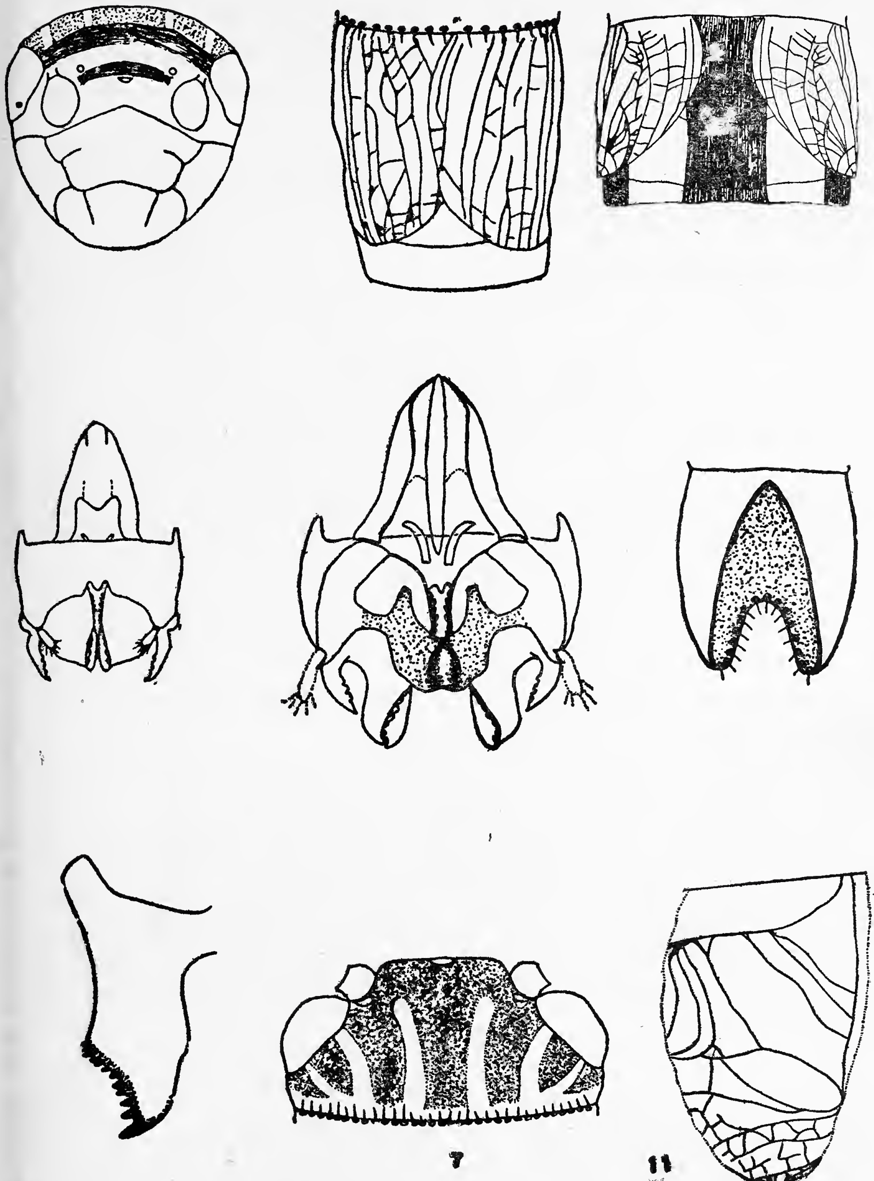


Fig. 1. *Gryllopsis rajasthanensis*, female head, dorsal view. x 17; Fig. 2. ibid., elytra. x 15; Fig. 3. *Turanogryllus rufoniger*, male genitalia, dorsal view. x 18; Fig. 4. ibid., male genitalia, ventral view. x 18; Fig. 5. ibid., apical end of ventral lobe of ectoparamere. x 55; Fig. 6. ibid., subgenital plate of an advanced nymph. x 20; Fig. 7. *Turanogryllus jammuensis*, female head, dorsal view. x 17; Fig. 8. ibid., pronotum and elytra. x 15; Fig. 11. *Turanogryllus histrio*, male elytra. x 15.2.

the median line and are obliquely truncated at apex; dorsal field with five oblique veins besides a sort of a branch from the discoidal; humeral edge brownish and lies in a line with the pronotal band; lateral lobes with four regularly spaced oblique veins; the mediastinal vein with one branch at the apex.

Measurements (in mm): Female: Length of body 9.75; length of pronotum 2; width of pronotum 2.75; elytra 2.6; posterior femora 7; posterior tibiae 4.5; ovipositor 5.7.

Distribution: Rajasthan.

Material examined: 1 female from Gudha (Rajasthan), Coll. T.G. Vazirani, dated 4.11.1958.

Gryllopsis falconneti (Saussure)

1877. *Gryllodes falconneti* Saussure, *Me'm. Soc. phys. Hist. nat. Geneve*, 25: 230.

Additional characters: FEMALE: *Body* moderately stout, cylindrical. Head more wide than long (5-5.25 to 2.95-3 mm), occiput with or without ornamentation, when ornamented it is with four very short, yellow lines. Clypeofrontal suture slightly arcuate. Pronotum transverse, testaceous with blackish patches, anteriorly as wide as the head. Elytra separated by a distance of 1.5 to 2.25 mm. Ovipositor very long, apical valves rufous, acute and closed at rest. Subgenital plate testaceous, navicular and with a shallow apical emargination.

Measurements (in mm): Female: Length of body 13-16; posterior femora 10.5-11; ovipositor 18-18.25.

Material examined: 2 females from Rajaji Sanctuary (Saharanpur dist.); 2 females from Udhampur (Jammu).

Remarks: The species is remarkable for its three distinct longitudinal dark bands on abdomen, stout body, ornamented head, widely separated elytra and closed type of ovipositor. The description of male which is yet unknown is, however, essential to be sure about its position in the genus.

Genus *Turanogryllus* Tarbinskii

Turanogryllus Tarbinskii, 1940, *Salt. Orth. Ins. Azeb. S.S.R.*, 19,115.

Diagnosis: The most important diagnostic feature of *Turanogryllus* is the presence of styli on the posterolateral extremities of epiphallus. Spherically convex head, quite lateral lobiform female elytra, triangular and strong, longitudinally sulcated male supra anal plate often with two spinules, somewhat bilobed subgenital plate in both sexes and externally visible dorsal lobes of ectoparameres are also remarkable.

Distribution: Russia; Africa; Western Asia; Pakistan and India.

KEY TO INDIAN SPECIES[1]

1(4) Elytra as long as the abdomen
2(3) Body cylindrical; clypeofrontal suture moderately arcuate; head blackish brown with four distinct yellow lines on occiput ....*quadrilineatus* (Bh.)
3(2) Body rather depressed; clypeofrontal suture indistinct, straight; head strongly rounded and without any ornamentation ....*dehradurensis* (Bh.)
4(1) Elytra shorter
5(8) Clypeofrontal suture more or less strongly arcuate
6(7) Pronotum dark brown with light impressions; two oblique veins; female elytra rudimentary or absent ....*virgulatus* (Bol.)
7(6) Pronotum brown varied with blackish brown spaces; female elytra short, obliquely truncated and separated from each other by a short distance; abdomen with three dark brown bands ....*jammuensis* (Bh.)
8(5) Clypeofrontal suture almost straight or a little arcuate
9(10) Pronotum fulvous with a wide posterior brown band; three to four oblique veins; female elytra longer than the metanotum, separated by a very narrow space ....*rufoniger* (Ch.)
10(9) Pronotum without any posterior band; clypeofrontal suture a little arcuate; female elytra short, widely separated ....*histrio* (Sauss.)

Turanogryllus dehradurensis Bhowmik

1969. *Turanogryllus dehradurensis* Bh., *Zool. Anz., Bd.* 182, *Heft* 1/2: 143-144.

The species was described on the male only. Since its publication, new material has become available from Bihar and the Punjab and from the latter a female specimen was obtained, and is described here.

FEMALE: Size large, head dark brown, pronotum and abdomen generally rufous brown whereas the dorsum of abdomen is dark brown variegated with brownish spaces; head rather larger and wider than that of male; frontal rostrum about two and half times as wide as the first antennal segment; post clypeus yellowish white as in male from Panipat. Pronotum slightly widened at anterior margin; lateral lobes almost concolorous with the pronotum. Elytra oblique, as long as the mesonotum and separated from each other by a width which is more than the dorsal width of any one of them and with five longitudinal veins. Ovipositor rufous brown, as long as the length of body, moderately curved upwards and with acute apical valves; subgenital plate yellowish with distinct concave apex, thus giving it a bilobed appearance. Posterior femora stout, shiny rufous brown throughout; rest of the posterior legs yellowish; posterior metatarsi with five brownish denticles on each margin. *Measurements* (in mm): Female: Length of body 18.5; length of pronotum 4.5; width of pronotum 6; elytra 2.75; gap of elytra at base 2.5; posterior femora 13.25; posterior tibae 9.5; ovipositor 19.5.

[1] *T. babaulti, T. maculithorax* & *T. fascifrons* described in the fauna by Chopard (1969) are not included in the key.

Material examined: 1 male from Hazaribagh (Bihar); 1 male and 1 female from Panipat, Karnal dist. (Punjab).

Turanogryllus quadrilineatus Bhowmik
(vide 1969. *Zool. Anz.*, 182, 1/2: 144-145)

Additional material of this species is not available for study.

Turanogryllus rufoniger (Chopard) (Figs. 3, 4, 5 & 6)

1925. *Gryllodes rufoniger* Chopard, *Ann. Soc. ent. France*, 94: 292.
1963. *Paragryllopsis rufoniger* Chopard, *Bull. Res. concil Israel*, 11*B*: 169.
*1967. *Turanogryllus rufoniger* Chopard, *Orth. Cat.*, 10.
Additional characters: MALE: Head deep brown with six distinct testaceous lines on occiput and vertex; clypeofrontal suture appears straight but effaced at the middle; a longitudinal suture extends from anterior ocellus to the extremity of anteclypeus. Pronotum almost parallel sided or slightly widened at posterior end but in the specimens from Dehra Dun the anterior end narrowed while the posterior end gradually widens; inferior margin of lateral lobes of pronotum straight, with angles almost rounded. Knees of posterior femora brown; posterior tibia with five to six internal and six external spines. Elytra testaceous brown and cover the abdomen; mirror oblique, rounded anteriorly, divided by a distinct curved vein, more than one and half times as wide as long, connected to first chord by one or two veinlets; oblique vein varies from three to four, in one example the last oblique being biforked; three chords of which first two strongly curved; apical field short, with four clear veins and with rectangular areolae; lateral field testaceous, with seven regularly spaced, moderately curved veins, mediastinal vein triramous. Subgenital plate bilobed at apex. Genitalia typical for the genus, the posterior emargination of epiphallus penetrating up to about half of the entire length and with a V-shaped projection in the middle; the dorsal lobe of ectoparameres with a lateral process which is digitiform (three to four digits) on its inner face, apical end of the ventral lobe with twelve denticles.
FEMALE: Completely tallys with Chopard's (1925) original description.
Immature stages: Immature stages of the species are readily recognizable but some minor variations are found in colour pattern, elytra and genital apparatus etc.

In two immature females (length of body 12mm, ovipositor 3mm) abdominal dorsum not entirely black but with two lateral and one median longitudinal blackish brown bands; elytra present as lateral pads only.

In four immature males (length of body 8 mm to 13 mm and width

about 1.5 mm long, overlapping elytral pads) and in one female (length of body 11 mm) the colour bands are on lateral margin of pronotal disc and not on anterior and posterior borders.

Measurements (in mm): Male: Length of body 13.5-14; length of pronotum 3-3.3; width of pronotum 5-5.5; elytra 8-9.5; posterior femora 10-11; posterior tibiae 7-7.25.

Female: Length of body 14.75-16.25; length of pronotum 5.25-5.8; elytra 3.25-3.75; posterior femora 10.75-11.5; ovipositor 12.9-13.6.

Material examined: 2 males, 2 females from Mysore city (University campus); 1 female from Gagret forest, Dist. Hoshiarpur (Punjab); 1 male from Hispana river, Dehra Dun.

Remarks: The species is readily identifiable by its particular colour pattern of head and of pronotum.

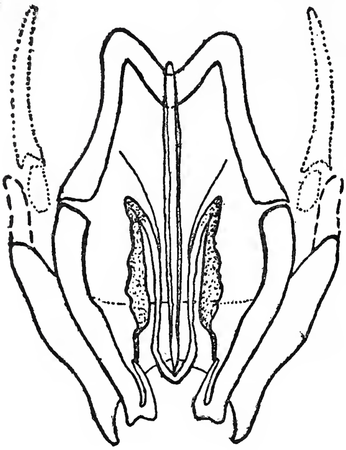
Turanogryllus jammuensis (Bhowmik) (Figs. 7, 8 & 9)

1967. *Gryllopsis jammuensis* Bhowmik, *Proc. Ind. Sci. Cong. Assoc. Benaras*, Part B: 491.

1969. (?) *Gryllopsis pakistana* Chopard, *Fauna Ind. Grylloidea*, 2:75.

Description: FEMALE: Size medium. Body moderately cylindrical, sparsely pubescent and testaceous varied with brown. Head rounded, dark brown, shiny and with six distinct yellow longitudinal lines, the lateral two of which are united at base and end near the eyes; front slightly flattened; frontal rostrum nearly twice as wide as the first antennal segment. Face yellow; clypeofrontal suture moderately arcuate. Eyes black, prominent and oval. Pronotum transverse, slightly narrowed both in front and behind, with both anterior and posterior margins straight; disc somewhat convex, varied with brown to blackish brown spaces, sparsely pubescent; lateral lobes yellowish except the extreme superior margins which are deep black, rounded at anterior angle, inferior margin slightly ascending posteriorly. Abdomen thinly hairy with a very prominent longitudinal median and two lateral blackish bands on the dorsum, ventrum yellowish. Ovipositor long and straight, inferior apical valves a little shorter than the superior ones. Legs testaceous. Anterior tibiae with a long oval tympanum at their external faces only. Posterior femora moderately stout, striated with brown at external faces, tibiae with six internal and seven external spines, the first external being very small. Elytra about 3 mm long and separated from each other by less than 1 mm distance, obliquely truncated; dorsal field shiny brown with four complete and slightly oblique veins, the venation is confused in the space between the fourth vein and the second discoidal; lateral lobes yellowish, with six regularly spaced veins, the mediastinal having a small branch at apex.

Measurements (in mm): Female: Length of body 12; length of pronotum 3; width of pronotum 4; elytra 3; posterior femora 10; posterior tibiae 7; ovipositor 11.



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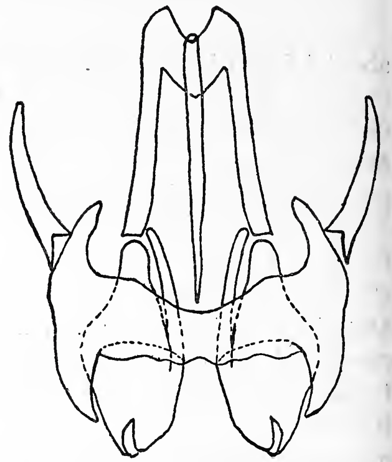

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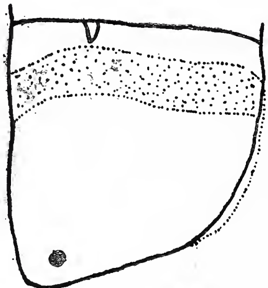

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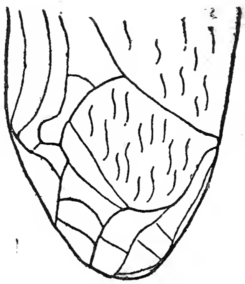

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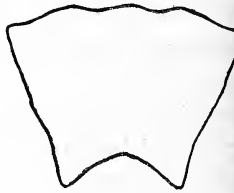

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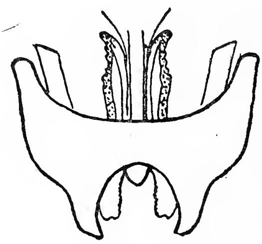

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Fig. 9. *Turanogryllus jammuensis,* ovipositor. x 25; Fig. 10. *Turanogryllus virgulata,* male clypeofrontal suture. x 15; Fig. 12. *Turanogryllus histrio,* lateral pronotal lobe. x 22; Fig. 13. ibid., subgenital plate. x 25; Fig. 14. ibid., ovipositor. x 25; Fig. 15. *Coiblemmus compactus,* male genitalia, ventral view. x 20; Fig. 16. *Stephoblemmus humbertiellus,* male elytron, apical portion. x 10; Fig. 17. ibid., male genitalia, dorsal view. x 20; Fig. 18. ibid., male genitalia, ventral view. x 20.

Material examined: 1 female from Jhajjar (Jammu & Kashmir), coll. R. Tilak, dt. 5. 10. 1964.

Remarks: The species somewhat resembles *T. rufoniger* in its general aspect and coloration but can be easily separated by its longer elytra and their close approximation, sparse pubescence etc. Male yet unknown.

The description of the species shows that it is very close to the female of *G. pakistana* Ch. (1969) and the latter may turn to be a synonym. At present it has been provisionally included in the synonymy list.

Turanogryllus virgulatus (Bolivar) (Fig. 10)

1900. *Gryllodes virgulatus* Bolivar, *Ann. Soc. ent. France 68*:797.
1933. *Gryllopsis virgulatus* Chopard, *Rev. Suiss, Zool., 40*:163.
1963. *Paragryllopsis virgulatus* Chopard, *Bull. Res. Council, Israel,* 11 B:169.
1964. *Turanogryllus virgulatus Randell, Canad. Ent., 96*:1571; Chopard. 1967, *Orth. Cat., 10.*

Additional characters: MALE: General coloration dark brown, shiny. Head strongly rounded, glossy, without ornamentation; frontal rostrum strongly convex, about twice as wide as the first antennal segment; facial parts testaceous rufous. Pronotum concolorous with head, anterior margin slightly concave, posterior margin straight, nearly parallel sided or very indistinctly narrowed at anterior end; disc convex with two pyriform brownish impressions at the middle; inferior margin of lateral lobes testaceous rufous while the superior margin concolorous with the pronotum and with the anterior angle nearly rounded and the posterior angle a little ascending. Dorsum of abdomen dark brown while the ventrum concolorous with facial parts, no incision on metasternal plate. Legs hairy, testaceous. Anterior tibia with an oval external tympanum. Posterior femora stout, posterior tibia with five internal and six external spines, the supero internal spurs equal in length to supero intermediate ones; posterior metatarsi with five to six brown denticles. Elytra cover the abdomen; two curved oblique veins; mirror more wide than long, postero-inferior angle broadly rounded, divided by a curved vein at the middle and united to the first chord by one veinlet; apical field very small and reduced to a few irregular areolae where two oblique veins and one false vein are recognizable.

FEMALE: Differs from male in being apterous and in having the colour of head, pronotum, abdominal dorsum much darker and size bigger; ovipositor remains open at rest, testaceous, straight, apex very acute. In one specimen from Mt. Stuart, Madras, the posterior tibiae with seven internal and six external spines; subgenital plate a little concave at apex but not bilobed as in other species of the genus.

Measurements (in mm): Male: Length of body 10.5-10.75; length of

pronotum 2.75-3; width of pronotum 3.5-3.8. Female: Length of body 12-16; length of pronotum 2.75-3.5; width of pronotum 4-4.25; ovipositor 8.5-10.

Material examined: 2 males, 1 female from Mysore city; 1 female from Nilgiri Hills (alt. 2628 m); 1 female from Mt. Stuart (Madras).

Remarks: The species is readily recognizable by its blackish appearance, somewhat depressed shape of female with its open type of ovipositor. It is only known from south India.

Turanogryllus histrio (Saussure) (Figs. 11, 12 13 & 14)

1877. *Gryllodes histrio* Saussure, *M'em. Soc. phys. Hist. nat. Geneve, 25*:397.

1963. *Paragryllopsis histrio* Chopard, *Bull. Res. Council Israel, 11B*: 169.

*1967. *Turanogryllus histrio* Chopard, *Orth. Cat., 10.*

Additional characters: MALE: Head spherical and convex; occiput and vertex with six yellowish light lines; frontal rostrum wider than first antennal segment. Clypeofrontal suture slightly arcuate. Fourth segment of maxillary palpi shorter than third, fifth largest, widened opicad and obliquely truncated. Pronotum transverse; lateral lobes with rounded angles. Elytra a little shortened or as long as the abdomen; mirror almost transversely disposed, undivided; three oblique veins; apical field with somewhat irregular areolae. Anterior tibia with a long, oval internal and a very small rounded external tympanum; first external spine of posterior tibia denticle like. Supra anal plate with two spinule like projections. Subgenital plate more or less bilobed and projected much beyond the supra anal plate.

FEMALE: Differs from males in having reduced elytra which are widely separated, and with long, slender ovipositor with narrow and lanceolate apical valves.

Measurements (in mm): Male: Length of body 8-9.5; elytra 4.25; posterior femora 7-7.25.

Female: Length of body 11.5; posterior femora 8; ovipositor 7.

Material examined: 1 male from Kaziranga (Assam); 1 male, 1 female from Noorpur forest range, Dist. Gurdaspur (Punjab).

Remarks: The species is remarkable for its cylindrical, slender body with a brown band on the extreme superior margin of each pronotal lobe and two brown, prominent, spots near the postero median margin of pronotal disc.

Genus *Gryllodes* Saussure, 1874

Gryllodes sigillatus (Walker)

1869. *Gryllus sigillatus* Walker, *Cat. Derm. Salt. Br. Mus., 1*:46.

1877. *Gryllodes sigillatus* Saussure, *Me'm. Soc. phys. Hist. Nat. Geneva,*

25: 210; B. Bienko, 1933, *Bol. Soc. Esp. Hist. nat.*, *33*:325; Randell, 1964, *Canad. Ent.*, *96*:1588.

Additional characters: MALE: Pale yellowish to testaceous in colour. Body depressed. Head as wide as the pronotum anteriorly; front yellowish and sloping; frontal rostrum a little narrower than the first antennal segment with lateral sides characteristically dark brown. Pronotum transverse with silky pubescence, anterior margin slightly concave, posterior margin straight and with a characteristic irregular dark transverse band continuing on either side up to the lateral margin of the lateral lobes; disc flat, a little widened in the middle, with a longitudinal suture at the middle and with two pyriform colour impressions at the superior part. Elytra extend beyond half of abdomen (leaving last five tergites free); mirror obliquely disposed, antero-internal and postero-external angles somewhat rounded but the other two angles more or less angulated, divided by a curved vein at the middle and united to the first chord by one or two veinlets; diagonal straight, bifurcated at base and sometimes united with the first chord by a veinlet; anal field very sparsely reticulated; lateral field with four regularly spaced slightly curved veins; mediastinal vein with a short apical branch. Posterior femora rufous brown, stout, longer than posterior tibiae and with indistinct dark oblique striations on external faces; posterior tibiae with five spines on each margin.

FEMALE: Differs from male in having the elytra reduced to very small lateral pads. Ovipositor slender, subequal to posterior femora, with acute apical valves.

Immature stages: Females are apterous with reduced ovipositor while the males are with imperfectly developed elytra without clear neuration.

Measurements (in mm): Male: Length of body 12-14; length of pronotum 2.25-2.5; width of pronotum 3.75-4.25; elytra 4.75-5.5; posterior femora 9.5-11; posterior tibiae 7-7.5.

Female: Length of body 15.25-16; length of pronotum 2.5-3; width of pronotum 4.25-4.75; posterior femora 10.5-11.5; posterior tibiae 7.25-8; ovipositor 10.5-11.5.

Material examined: 1 male from Banisaugh (Jammu); 3 males, 21 females from Ambala (Punjab); 1 female from Dhaukhand Forest Range, Dist. Saharanpur; 3 males, 3 females from Dehra Dun; 2 males from Sahastna Dhara Hills, Dehra Dun; 1 female from Timli Forest Range, Dehra Dun; 1 female from Rajpur (Madhya Pradesh); 1 male from Santal Parganas (Bihar); 1 male from Subhasgram (W. Bengal); 5 males, 9 females from Calcutta; 1 male from Nagarjunsagar (Andhra Pradesh); 2 males, 1 female from adjoining area of Mysore city; 1 male from Couriaghat (south Andaman Island); 1 male from Mallaca village (Car Nicobar).

Remarks: The species is readily recognizable by its general appearance

and colour pattern and is commonly seen in undisturbed places in houses.

Genus *Itaropsis* Chopard, 1925
Itaropsis tenellus (Walker)

1869. *Gryllus tenellus* Walker, *Cat. Derm. Salt. Br. Mus., 1*:37.
Additional characters: FEMALE: Head shiny dark brown, with or without four indistinct brownish light lines on posterior head. Clypeofrontal suture almost straight. Pronotum almost parallel sided, both anterior and posterior margins straight; disc with two rufous brown pyriform impressions and with a median longitudinal suture. Elytra cover the abdomen in one specimen, in another, they are slightly shorter; dorsal field with four to five obliques, somewhat regularly spaced veins and one to two branches from the discoidal.
Measurements (in mm): Female: Length of body 11.5-12; elytra 8-9; posterior femur 8.5-9; posterior tibia 4.5-5.
Material examined: 1 female from Dehra Dun, coll. S. Lal, dt. 9-5-1961; 1 female from Mussoorie (Uttar Pradesh), coll. R. P. Mukherjee, dt. 5-12-1961.
Remarks: Female of this species is unique among the Gryllidae for its rudimentary ovipositor which is represented by a styliform process almost enclosed by the subgenital plate.

Genus *Coiblemmus* Chopard, 1936
Coiblemmus compactus (Chopard) (Fig. 15)

1928. *Homaloblemmus compactus* Chopard, *Spol. Zeyl., 14*:201.
Additional characters: MALE: Head slightly wider than pronotum. Frontal rostrum almost twice as broad as the first antennal segment. Lateral field of elytra yellowish and with four somewhat parallel and equidistant veins; the mediastinal vein with a branch originating either from its very base or at most from its basal half and also with a small apical branch. Male genitalia: Epiphallus roughly H-shaped when viewed dorsally, the anterior margin moderately emarginate, the emargination is maximum at the middle; the posterior margin roughly U shaped and also emarginate, posterior lobes become evenly pointed and are curved inwards. Ectoparamere, when viewed ventrally, appears as a stout and simplified structure, its posterior margin having the corners produced, pointed and curved dorsally, basal half of ectoparamere divided into two processi of unequal width, the anterior internal process being thinner and rod like, a little curved outwards and comparatively longer than the external one. The courses of mesal lobes cannot be completely seen. Endoparameres, on profile somewhat C shaped, basal union of two endoparameres greatly expanded and with inwardly angulated lateral

processi. Virga unspecialized, moderately long and quite narrow.
Measurements (in mm): Male: Length of body 14-14.8; length of pronotum 3.2-3.5; elytra 7.8-8.25; posterior femora 10.25-10.6; posterior tibiae 6.9-7.25.
Material examined: 2 males from Mysore city (University campus), coll. S. Vasantha, dt. 1964.
Remarks: This monotypic genus is widely distributed in Ceylon and less commonly in Tamil Nadu. The male genitalia has been described elaborately for the first time.

Genus *Stephoblemmus* Saussure, 1877

Stephoblemmus humbertiellus Saussure (Figs. 16, 17 & 18)

1877. *Stephoblemmus humbertiellus* Saussure, *Mem. Soc. Phys. Hist. nat. Geneve, 25*:428.

Additional characters: The specimen at hand tally in majority of characters with the description and diagrams given by Saussure (1877) but some minor variations are also found viz., the mediastinal vein in left elytron with two branches at apex and in the right one with one branch; lateral field with three prominent but irregular and slightly curved veins, the middle one biforked apically in left lateral field; apical field comprised of a few irregular but distinct areolae; anterior tibiae with a small internal and a moderately long, oval external tympanum in each; posterior tibiae with five internal and six external spines in each.
Male genitalia: The genitalia in general resembles that of genus *Miogryllus* Saussure and thus it should be placed in the subtribe Sciobiina Bolivar (Vide Randell 1964, *Canad. Ent., 96*:1589).
Epiphallus: Distinctly H shaped in dorsal view, emargination of anterior border rather very broad and relatively deep, reaching up to one third the length of epiphallus; emargination of posterior border noticeably narrower but reaching still deeper; the bridge formed by the two emarginations is about one third the entire length; anterior internal apodemes moderately long. Ectoparameres almost rod like, slightly incurved structures with spine like projections at apices and each is bent on itself. Mesal lobes remarkably prominent in the form of a double ribbon, the external process very thin, irregular but comparatively broader and connected with the spine like projection of the ectoparamere by a thread like connection which can be seen only on profile, the internal process descends downwards as a narrow process, one on each side of the virga and ultimately united with each other forming a V shaped projection just on the medio-posterior emargination of epiphallus and is visible both dorsally and ventrally. Endoparameres J shaped on profile and with the antero-ventral edge weakly expanded. Virga long, narrow, and unspecialized; basal portion connected by the expanded bases of the endoparameres; the apical portion being visible dorsally

in between the apices of the mesal lobes. Rami simple, rod shaped, a little expanded and shallowly divided at their dorsal extremities. Ramal plates cannot be traced.

Measurements (in mm): Male: Length of body 10; elytra 5.25; wings 14; posterior femora 7.25; posterior tibiae 5.25; width of frontal lamellar process 5.2.

Material examined: 1 male from Rajaji Sanctuary, Dist. Saharanpur (Uttar Pradesh), Coll. T. D. Soota, Dt. 13-7-1963.

Remarks: This species of the monotypical genus is reported for the first time from India. The species is rare since the specimen dealt with here is the third one known so far.

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Crop preference of rodents at Ludhiana[1]

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Rodents are the most destructive vertebrate pests of field crops in the Punjab. The loss from rodents to wheat, groundnut and sugarcane crops were reported by Bindra & Prem Sagar (1968). However, relatively little is known about the preference of different species for different field crops.

Materials and methods

Capture, mark, release and recapture method (Davis 1964) using 2 types of wonder traps (Deoras *et al.* 1969) to avoid cannibalism was employed. In one type, the entrance was only 4 × 2 cm, so that *Bandicota bengalensis* (Gray) and *Tatera indica* (Hardwicke) could not enter, and the pressing-disc was so adjusted that the animal weighing as little as 5 gm could enter. In the other type, the pressing disc was so adjusted that the animals weighing less than 20 gm could not enter. A mixture of husked rice, *bajra* (Pearl-millet) and wheat was used as bait. The traps were laid in different crops at a distance of 100 m from one another in a 53 ha cultivated area of the Punjab Agricultural University Farm, Ludhiana. This study was conducted during December 1970 to November 1972 for a 10-day period in the first fortnight of each month. month.

The preference was determined by using the following preference categories.

Categories of crop preference based on the number of specimens per species per trap per day (x 10^3).

Species	Highly preferred	Moderately preferred	Less preferred
Mus musculus bactrianus Blyth	200-650	100-199	0-99
Mus booduga (Gray)	100-450	10-99	0-9
Rattus meltada (Gray)	100-650	10-99	0-9
Tatera indica (Hardwicke)	100-158	10-99	0-9
Total	600-975	300-599	0-299

Results and discussion

The observed preferences by different species are given in Table 1, and are discussed below briefly.

[1] Accepted January 1974.

Species	Season	Highly preferred	Moderately preferred	Less preferred
Mus musculus bactrianus	*Rabi*	Fenugreek, Potato, radish, spinach and tomato.	Barley, *sarson* and *sarson* + Egyptian clover	*Ber* orchard, cauliflower, Egyptian clover, lentil, lucerne, oat, pea, *toria* and wheat.
	Kharif	Fodder, groundnut and sugarcane.	Brinjal, cluster-bean, cow--pea, *desi* cotton, *jantar*, pearl-millet, sorghum and soybean.	American cotton, bitter-gourd, bottle-gourd, carrot (seed), chickory, citrus orchard, green-gram, *kaahi*, mango orchard, maize, musk-melon, Napier-*bajra* hybrid, onion (seed), pigeon-pea, squash-melon sweet-potato, turmeric and water-melon.
Mus booduga	*Rabi*	Radish and *sarson* + Egyptian clover.	potato, tomato, *toria*, Fenugreek, lentil, oat, and wheat.	Barley, *ber* orchard, cauliflower, Egyptian clover, lucerne, pea, *sarson* and spinach.

Species	Season	Highly preferred	Moderately preferred	Less preferred
	Kharif	Groundnut.	American cotton, Citrus orchard, chickory, cluster-bean, *desi* cotton, fodder, green-gram, *jantar*, maize, mango orchard, musk-melon, pearl-millet, sorghum, soybean and sugarcane.	Bitter-gourd, bottle-gourd, brinjal, cow-pea, *kaahi*, Napier-*bajra* hybrid, onion (seed), pigeon-pea, squash-melon, sweet-potato, turmeric and water-melon.
Rattus meltada	*Rabi*	Cauliflower and onion.	*Ber* orchard, Egyptian clover, lentil, oat, potato, *sarson*, *sarson* + Egyptian clover, tomato, and wheat.	Barley, fenugreek, *metha*, pea, radish, spinach, and *toria*.
	Kharif	cow-pea, fodder, groundnut, pearl-millet, and soybean.	American cotton, bitter-gourd, black-gram, bottle-gourd, brinjal, citrus orchard, cluster-bean, *desi* cotton, green-gram, *jantar*, maize, mango orchard, musk-melon, Na- potato and water-melon. pier-*bajra* hybrid, pigeon-pea, radish (seed), sorghum, sugarcane, sweet-	carrot (seed), chickory, *kaahi*, okra, onion (seed), squash-melon, and turmeric.

Species	Season	Highly preferred	Moderately preferred	Less preferred
Tatera indica	*Rabi*	*Metha*	Lentil, onion, *sarson* and *toria.*	Barley, *ber* orchard, Egyptian clover, lucerne, oat, potato, *sarson* + Egyptian clover, tomato and wheat.
	Kharif	Brinjal	American cotton, chickory, cluster-bean, *desi* cotton, fodder, green-gram, *jantar*, maize, Napier-*bajra* hybrid, okra, pearl-millet and sorghum.	Black-gram, bottle-gourd, citrus orchard, mango orchard, musk-melon, squash-melon, pigeon-pea, radish (ssed), soybean, sugar-cane, sweet-potato and water-melon.

TABLE 1

CROP PREFERENCE BY DIFFERENT SPECIES OF RODENTS DURING DECEMBER 1970-NOVEMBER 1972 ON THE PAU FARM, LUDHIANA

Crop	Number of rodents per trap per day (x 10^3)							
	M.m.b.	*M.b.*	*M.p.*	*R.m.*	*B.b.*	*G.e.*	*T.i.*	*Total*
1	2	3	4	5	6	7	8	9
CEREALS								
Barley	100(1+1)	0(1+1)	0(2+2)	1(2+2)	0(1+1)	0(2+2)	0(1+1)	101
Oat	58(3+1)	17(3+1)	39(9+3)	64(9+3)	0(6+2)	0(9+3)	4(6+2)	182
Maize	59(9+9)	16(9+9)	1(21+21)	34(21+21)	4(12+12)	0(21+21)	21(12+12)	135
Pearl-millet	186(3+1)	14(3+1)	5(5+6)	140(5+6)	0(2+5)	0(5+6)	12(2+5)	357
Wheat	86(15+15)	20(15+15)	1(38+39)	35(38+39)	5(23+24)	1(38+39)	6(23+24)	154
PULSES								
Black-gram	0(0+0)	0(0+0)	0(1+0)	67(1+0)	0(1+0)	0(1+0)	0(1+0)	67
Green-gram	89(3+3)	28(3+3)	0(6+6)	86(6+6)	0(3+3)	0(6+6)	11(3+3)	214
Lentil	22(0+1)	67(0+1)	0(0+2)	11(0+2)	0(0+1)	0(0+2)	22(0+1)	122
Pigeon-pea	13(3+3)	0(3+3)	1(8+8)	25(8+8)	0(5+5)	0(8+8)	0(5+5)	39
Soybean	100(1+0)	33(1+0)	0(3+0)	178(3+0)	0(2+0)	0(3+0)	0(2+0)	311
OILSEEDS								
Groundnut	300(1+0)	450(1+0)	25(1+0)	200(1+0)	0(0+0)	0(1+0)	0(0+0)	975
Sarson	100(1+1)	0(1+1)	0(3+3)	16(3+3)	0(2+2)	0(3+3)	39(2+2)	155
Toria	67(1+1)	17(1+1)	0(3+3)	6(3+3)	0(2+2)	0(3+3)	17(2+2)	107

M.m.b. = *Mus musculus bactrianus*, *M.b.* = *Mus booduga*, *M.p.* = *Mus platythrix*, *R.m.* = *Rattus meltada*, *B.b.* = *Bandicota bengalensis*, *G.e.* = *Golunda ellioti*, *T.i.* = *Tatera indica*.

TABLE 1 (contd.)

Crop 1	*M.m.b.* 2	*M.b.* 3	*M.p.* 4	*R.m.* 5	*B.b.* 6	*G.e.* 7	*T.i.* 8	*Total* 9
SUGAR CROPS								
Sugarcane	252(2+2)	27(2+2)	1(4+4)	68(4+4)	14(2+2)	6(4+4)	0(2+2)	368
Sweet-potato	80(1+0)	0(1+0)	0(3+1)	35(3+1)	7(2+1)	0(3+1)	7(2+1)	129
FODDER								
Cow-pea	100(1+0)	0(1+0)	0(1+0)	650(1+0)	0(0+0)	0(1+0)	0(0+0)	750
Egyptian clover	56(0+4)	6(0+4)	4(0+7)	29(0+7)	0(0+3)	0(0+7)	0(0+3)	95
Lucerne	57(3+2)	7(3+2)	0(5+5)	45(5+5)	5(3+2)	13(5+5)	2(3+2)	129
Napier-*bajra* hybrid	48(2+3)	4(2+3)	6(4+6)	45(4+6)	10(2+3)	5(4+6)	44(2+3)	162
Sarson + Egyptian clover	188(0+4)	150(0+4)	71(0+7)	71(0+7)	0(0+3)	0(0+7)	0(0+3)	480
Sorghum	175(1+0)	75(1+0)	25(3+0)	92(3+0)	25(2+0)	0(3+0)	13(2+0)	405
Fodder*	358(5+5)	58(5+5)	44(11+11)	105(11+11)	21(6+6)	7(11+11)	40(6+6)	633
SUMMER VEGETABLES								
Bitter-gourd	25(1+1)	0(1+1)	0(1+1)	25(1+1)	0(0+0)	0(1+1)	0(0+0)	50
Bottle-gourd	86(2+2)	0(2+2)	0(3+3)	33(3+3)	14(1+1)	0(3+3)	0(1+1)	133
Brinjal	152(3+4)	5(3+4)	0(5+6)	42(5+6)	0(2+2)	0(5+6)	158(2+2)	357
Musk-melon	50(2+2)	25(2+2)	0(3+3)	17(3+3)	17(1+1)	0(3+3)	0(1+1)	109
Okra	0(0+0)	0(0+0)	0(2+2)	8(2+2)	0(2+2)	0(2+2)	50(2+2)	58
Squash-melon	50(0+1)	0(0+1)	0(1+1)	0(1+1)	50(0+1)	0(1+1)	0(0+1)	100

*(mixture of pearl-millet, cow-pea, cluster-bean and sorghum)

TABLE 1 (contd.)

Crop 1	*M.m.b.* 2	*M.b.* 3	*M.p.* 4	*R.m.* 5	*B.b.* 6	*G.e.* 7	*T.i.* 8	*Total* 9
Water-melon	88(2+2)	0(2+2)	0(3+3)	58(3+3)	0(1+1)	0(3+3)	0(1+1)	146
WINTER VEGETABLES								
Cauliflower	0(1+1)	0(1+1)	0(1+1)	183(1+1)	0(0+0)	0(1+1)	0(0+0)	183
Carrot (seed)	25(1+1)	0(1+1)	0(1+1)	0(1+1)	0(0+0)	0(1+1)	0(0+0)	25
Fenugreek	550(0+1)	50(0+1)	0(0+1)	0(0+1)	0(0+0)	0(0+1)	0(0+0)	600
Onion	0(0+0)	0(0+0)	0(1+1)	117(1+1)	0(1+1)	0(1+1)	17(1+1)	134
Onion (seed)	25(1+1)	0(1+1)	0(1+1)	0(1+1)	0(0+0)	0(1+1)	0(0+0)	25
Metha	0(0+0)	0(0+0)	0(0+1)	0(0+1)	0(0+1)	0(0+1)	100(0+1)	100
Pea	50(1+0)	0(1+0)	0(1+0)	0(1+0)	0(0+0)	0(1+0)	0(0+0)	50
Potato	340(1+1)	20(1+1)	0(3+3)	87(3+3)	0(2+2)	0(3+3)	0(2+2)	447
Radish	650(1+0)	300(1+0)	0(1+0)	0(1+0)	0(0+0)	0(1+0)	0(0+0)	950
Radish (seed)	0(0+0)	0(0+0)	0(1+0)	67(1+0)	0(1+0)	0(1+0)	0(1+0)	67
Spinach	200(1+0)	0(1+0)	0(1+0)	0(1+0)	0(0+0)	0(1+0)	0(0+0)	200
Tomato	248(4+3)	57(4+3)	3(6+5)	73(6+5)	0(2+2)	0(6+5)	8(2+2)	389
FRUIT TREES								
Ber	17(3+3)	3(3+3)	1(9+9)	14(9+9)	0(3+3)	0(9+9)	0(3+3)	35
Citrus	51(6+6)	24(6+6)	7(9+9)	40(9+9)	0(3+3)	0(9+9)	1(3+3)	123
Mango	50(3+3)	24(3+3)	6(9+9)	54(9+9)	6(6+6)	1(9+9)	1(6+6)	142
MISCELLANEOUS								
Americon cotton	24(3+3)	38(3+3)	1(8+8)	18(8+8)	0(5+5)	0(8+8)	13(5+5)	94
Desi cotton	150(1+1)	42(1+1)	25(2+2)	75(2+2)	0(1+1)	0(2+2)	67(1+1)	359
Cluster-bean	147(6+4)	90(6+4)	7(12+8)	93(12+8)	3(6+4)	0(12+8)	10(6+4)	350

TABLE 1 (contd.)

Crop 1	*M.m.b.* 2	*M.b.* 3	*M.p.* 4	*R.m.* 5	*B.b.* 6	*G.e.* 7	*T.i.* 8	*Total* 9
Jantar	144(3+0)	22(3+0)	11(5+1)	33(5+1)	11(2+1)	0(5+1)	33(2+1)	254
Chickory	67(1+0)	33(1+0)	0(2+0)	0(2+0)	0(1+0)	0(2+0)	33(1+0)	133
Kaahi	33(1+0)	0(1+0)	0(1+0)	0(1+0)	0(0+0)	0(1+0)	0(0+0)	33
Turmeric	3(0+1)	0(0+1)	0(0+1)	0(0+1)	0(0+0)	0(0+1)	0(0+0)	3
After harvesting of different crops*	16	0	1	10	1	0	0	
Ploughed fields before sowing*	34	32	0	44	0	0	20	

Parentheses are the number of traps used during December 1970-November 1971 and those during December 1971-November 1972.

* Total number of rodents trapped.

The pooled data of all the species of rodents shows their preference for cow-pea, fenugreek, fodder (mixture of pearl-millet, cow-pea, cluster-bean and sorghum), groundnut and radish, and followed by brinjal, cluster-bean, *desi* cotton, pearl-millet, potato, *sarson* + Egyptian clover, sorghum, soybean, sugarcane and tomato than the other crops (Table 1).

All the species, except *Tatera*, were found more in the closely-spaced crops. This difference might be due to the hopping type of movements of *Tatera*.

The frequent tillage operations that caused lack of weeds and dis-
However the rodents were found in a variety of crops, but the num-
turbed the habitat during early stages of growth of vegetables could explain the lower incidence of rodents during early stages than during later stages. Also, in fodder crops, absence of tillage operations might be responsible for the high incidence of rodents.
bers in which they were observed in different crops suggest that they exhibit preference for different crops. For instance, *Rattus* preferred onion, cauliflower and soybean; *M. booduga* preferred groundnut and radish; *M. m. bactrianus* preferred fenugreek, radish, spinach, tomato and potato; *M. platythrix* preferred oats; *Bandicota* preferred bottle-gourd, musk-melon, squash-melon, lucerne and wheat; *Golunda* preferred lucerne and *Tatera* preferred *metha* and brinjal. It would be desirable to examine as to whether these preferences are on the basis of the olfactory or gustatory stimuli presented by the crops.

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The cocoon spinning behaviour and fecundity of *Stegodyphus sarasinorum* Karsch (Araneae: Eresidae) from India[1]

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(*With seven text-figures*)

Observations on the sequence of cocoon spinning behaviour and fecundity of the social spider *Stegodyphus sarasinorum* Karsch (Eresidae) are given.

Introduction

In the genus *Stegodyphus*, cocoons have been observed by Marshall (1898), Jambunathan (1905), Millot & Bourgin (1942), Phanuel (1960) and Bradoo (1972a), but the mechanism of cocoon spinning in *Stegodyphus* has not been investigated before. The cocoon spinning behaviour among spiders affords a good example of a succession of instinctive responses controlled by both internal and external stimuli. The spinning activity is so organised that no stage can be omitted and no stage repeated. The different stages of this behaviour follow one after the other as in a chain automatic behaviour.

This paper, describes the sequence of cocoon spinning behaviour and fecundity of the social spider *S. sarasinorum* Karsch, common in Kerala, south India.

Methods of study

The cocoon spinning behaviour of *S. sarasinorum* Karsch, was studied in seven batches that were established in the laboratory. Each batch

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contained 5 to 10 gravid females placed within a loosely closed glass jar. After a few days of nest construction inside the jar, the females make their cocoon on the nest surface or on the web around the nest. As the cocoon spinning is a nocturnal activity in this spider, a dim torch light was used during the course of these observations.

The complete sequence of cocoon spinning behaviour was observed only seven times in the laboratory and the duration for each stage in the sequence, was recorded. The later stages of this sequence were also observed in several field colonies of this species that were regularly examined during the breeding season.

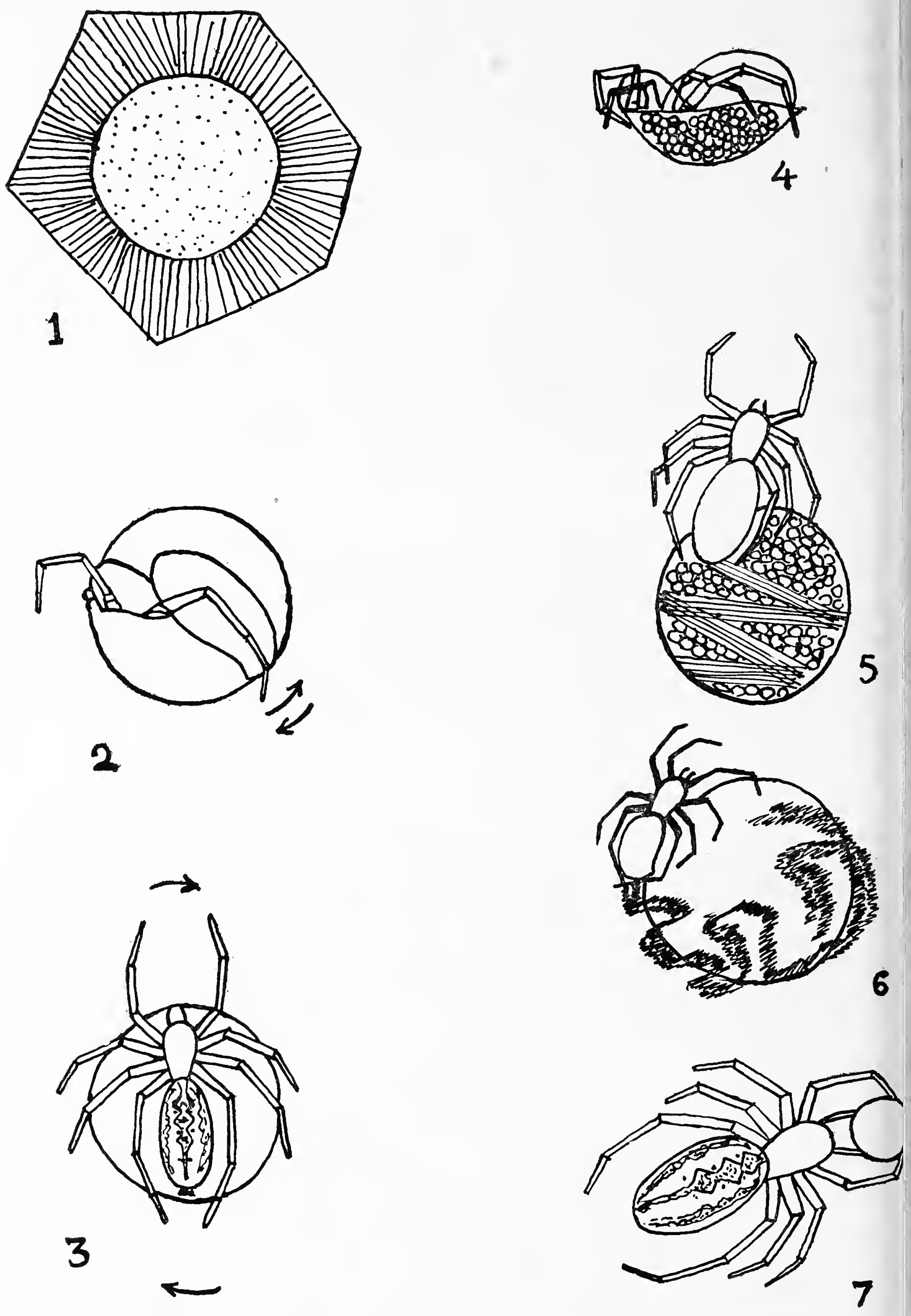
For studying the fecundity of *S. sarasinorum* Karsch, a total of 41 cocoons collected from different localities in Calicut (Kerala), were examined for egg count in the laboratory.

Cocoon spinning behaviour

S. sarasinorum Karsch, has an annual life history (Jambunathan 1905). The breeding season of this spider starts from the middle of January and continues till early April, but the maximum number of cocoons are made in the month of February. Marshall (1898) reports that the egg-laying season of a South African *Stegodyphus* sp. starts in the month of February or March and Millot & Bourgin (1942) report that the solitary species, *S. lineatus* lays eggs in the month of June, in southern Europe.

Behaviour of gravid females. The gravid females of *S. sarasinorum* are larger in size and they move more slowly than the normal females. The gravid females bear well developed and functional silk glands (Bradoo & Majupuria 1973), but they do not take an active part in snare construction. They feed on prey, captured mostly by other members of the colony. During the breeding season, gravid females construct several brood chambers lined with soft cribellar silk for storing their cocoons, within the tunnels of their nest. This makes the nest architecture suitable for the breeding purpose and for the new generation of spiders that hatch from the cocoons.

The gravid females also spend most of their time in 'toilet movements', grooming the dorsal surface of the abdomen with hind legs, upper side of the cephalothorax with anterior legs and they groom their appendages with one another. Such toilet movements are more commonly performed by the mature and the gravid females of the colony. The gravid females also take part in colony foundation, as they leave their nest, individually or in groups of few individuals and then they establish new breeding nests, close to the parent nest (Bradoo 1972b). Each gravid female makes a total of 2 to 4 cocoons during the breeding season.



The Cocoon spinning behaviour of *S. sarasinorum* Karsch.
Fig. 1. Platform with the central disc; Figs. 2 and 3. Construction of the receiving valve; Fig. 4. Oviposition; Fig. 5. Concealing the egg-mass; Fig. 6. Spinning of Cribellar silk around the cocoon; Fig. 7. Transportation of the cocoon.

In *S. sarasinorum*, the cocoon spinning behaviour normally involves ten stages in the following sequence:

1. *Construction of the Platform*: The first step in cocoon spinning behaviour is the construction of a loose silken platform (Fig. 1) consisting of numerous closely arranged silk threads, placed side by side, close to the nest surface. The spinning of the platform is finished within about 9 to 15 minutes. The finished platform appears as an oblique or horizontal thin sheet of smooth supporting silk, on the upper middle surface of which the cocoon is spun.

The construction of the platform starts normally after midnight, when the other members of the colony are busy, either spinning cribellar silk on the web or feeding on some ensnared prey. The spinning of the platform indicates the start of the cocoon spinning behaviour and if the spider is disturbed at this stage, she at once retreats into her nest and never returns back to resume the work on the platform. The cocoon spinning is also suspended, as and when the spider receives strong web-signals from other members of the colony, rushing to their nest due to some disturbance in the surroundings. Undisturbed and calm surrounding is hence essential for the successful completion of the platform. After the platform is ready, the spider examines it by palpal contacts and quickly shakes her abdomen sidewise and this releases the next phase of the spinning behaviour i.e. the construction of the receiving valve.

2. *The Receiving Valve*: The receiving valve is made by rubbing the mid and hind spinnerets over the upper middle surface of the platform. During this process, the spider taps (dabs) her abdomen up and down, adding silk over the platform and at the same time, she changes her orientation, turning clockwise or anticlockwise. Such dabbing movements continues for a short time till the platform shows a thin smooth pinkish-white circular disc (Fig. 1), that later becomes the cup-like receiving valve of the cocoon. After the formation of this disc, the spider then thickens only the margin of the disc by making two types of spinning movements on the upper side of the disc. These movements include, (i) a short sidewise movement of the abdomen, resulting in the repeated brushing of the spinnerets along the margin of the disc. This results in the gradual thickening of the periphery of the disc that becomes the receiving valve (Fig. 2). (ii) The second type of movement involves the rotation of the spider (clockwise or anticlockwise) over the same upper side of the receiving valve. This results in a uniform thickening of the margin of the receiving valve so that a shallow depression is gradually formed in its middle (Fig. 3).

The above mentioned two spinning movements continue simultaneously, as the spinnerets add silk over the receiving valve. During this spinning activity, the spider receives tactile stimuli through the palps,

that are constantly kept in contact with the margin of the valve and it is accompanied by a slight arching of the abdomen. The palpal contact is necessary for the continuity of the spinning movements. A single rotation of the spider over the valve is completed in an average of one and a half minutes and such rotations continue for about 25 to 40 minutes, after which the construction of the receiving valve is complete. The receiving valve is supported by the platform.

3. *Rest*: The completion of the receiving valve is always followed by about 4 to 5 minutes rest. During this period, the spider remains motionless over the receiving valve without making any visible movements. This duration may be necessary for the eggs to move down from the ovaries into the basal part of the oviducts for deposition.

4. *Oviposition*: The rest stage is followed by certain characteristic movements of the cephalothorax and up and down movement of the abdomen, accompanied by quick shivering of the legs. The spider remains flat and then adjusts her epigynal furrow over the receiving valve and within 2 or 3 minutes, she starts depositing her eggs. During this process, the spider again remains motionless, the anterior pair of legs remain deflexed beneath the cephalothorax. Some fluid is also secreted along with the eggs that keeps them glued into a single yellowish egg-mass as also reported in *S. lineatus* by Millot & Bourgin (1942). The completion of oviposition is followed by the next stage, provided the spider is not disturbed at this stage.

In some field colonies of *S. sarasinorum*, sometimes after oviposition, the spider suspends her further spinning activity due to some external disturbances and leaves her incomplete cocoon so that the egg-mass finally shrivels.

5. *Concealing the Egg-mass*: The eggs deposited within the receiving valve are immediately covered by loose thin silk threads taken out quickly from the spinnerets. In this process, the spider moves her abdomen sidewise, brushing her spinnerets very quickly over the surface of the egg-mass (Fig. 5) which is concealed in about 4 to 7 minutes. With each stroke of the abdomen, the spinnerets produce many straight silk threads extending from one to the other margin of the valve (Fig. 5). This phase is then followed by spinning of the covering valve.

6. *The Covering Valve*: The spinning of the covering valve is brought about by the repeated brushing of the spinnerets all over the concealed egg-mass, in a haphazard manner. The spider always changes her direction during this spinning activity. The spinning movements of this phase are exactly similar to those made at the start of the formation of the receiving valve. The covering valve is completed in about 40 to 50 minutes, after which it appears as a thin whitish papery cover over the eggs.

After the completion of the covering valve, the smooth double convex white cocoon is looked after by the mother. Even if disturbed, she

does not leave her cocoon now, but firmly holds it with her palps and legs. My observations revealed that it is mainly the size and the tactile stimuli from the cocoon surface that she responds to, as an empty cocoon from another nest of its kind would also be accepted by the mother, and looked after like her own cocoon. The gravid females, that have not oviposited, do not show maternal care, although they may accept cocoons temporarily.

These observations show that the maternal care in *Stegodyphus* starts shortly after the oviposition and completion of the covering valve of the cocoon and that this behaviour shown by the mother is instinctive, released probably by both internal and external stimuli. The internal stimulus probably comes from the brain while the external stimulus involves mainly the tactile stimuli received from the cocoon surface. That the central nervous system of spiders contain certain neurosecretory cells, has recently been reported by Legendre (1954a, 1954b, 1958) and Sasira Babu (1965).

With the completion of the covering valve of the cocoon, the spider continues the next phase of her behaviour.

7. *Removal of some supporting threads*: The completion of the covering valve is followed by the removal of a few supporting silk threads present around the cocoon. The mother slowly cuts only a few of these silk threads of the platform by the help of her chelicerae within 2 to 5 minutes and this results in a slight tilt in the original flat position of the cocoon. The cocoon becomes slightly free along one side. This is followed by the next phase, the spinning of the cribellar silk.

8. *Cribellar silk*: For the first time in cocoon spinning behaviour, the spider starts spinning sticky cribellar silk over the cocoon surface and along the margin (Fig. 6). This provides a firm attachment between the two valves of the cocoon. The spinning of cribellar silk is a slow process for which both the hind legs are used by the spider and this stage lasts for about 35 to 49 minutes. Like *Stegodyphus,* other cribellates also cover their cocoons with cribellar silk and this has certain advantages. Norgaard (1941) reports that the cocoons of *Eresus niger* Pet. are covered with cribellar silk and many foreign bodies like sand grains, remains of prey and plant matter are also added to camouflage the cocoon. Bradoo (1972b) found a *Uloborus* spider covering her bag-like cocoon with cribellar silk, that is useful to a great extent for preventing the ovipositional activity of its egg parasite. In *S. sarasinorum* the cribellar silk not only unites the two valves of the cocoon but it also provides a rough surface for convenient transportation by the mother. The adhesive cribellar silk also protects the cocoon from ants that sometimes raid the nests of social spiders (Bradoo 1972a).

9. *Separation of the Cocoon*: After adding some cribellar silk over the cocoon surface, the mother cuts all the remaining supporting threads

of the platform in about 10 minutes around the cocoon. The cocoon becomes free from the platform and the spider then removes the cocoon that may be covered with additional sticky cribellar silk before it is carried to the nest.

10. *Transportation*: This is the last phase of the cocoon spinning behaviour. The cocoon after it is completely free, is carried by the mother within 1 to 3 minutes towards her nest. The method of transportation of the cocoon is different from the method used in transport of prey. The prey is practically dragged by several spiders towards the nest, but the cocoon is held by the palps and one or two anterior legs (Fig. 7), and is carried by the female into the brood chamber of her nest. The mother remains with the cocoon and she is often observed adding more cribellar silk on the surface of the cocoon. At times, she takes the cocoon out through a nest exit and exposes it to the rays of the sun. This behaviour has also been reported by Millot & Bourgin (1942) in *S. lineatus,* who believe that it is necessary for receiving the warmth from the sun.

The duration of different stages of cocoon construction is given in table 1. Each cocoon mesaures 6 to 8 mm in diameter.

The different silk glands involved in the construction of the cocoon in this social spider has been described in detail by Bradoo & Majupuria (1973). In addition to cribellar silk, produced by different glands, at least two types of silk glands, namely, cylindrical glands and tubular glands are involved in cocoon construction. These two kinds of glands are characteristic of females only.

TABLE 1

DURATION IN MINUTES OF TEN STAGES IN COCOON SPINNING BEHAVIOUR OF *S. sarasinorum* KARSCH

Stages	Dates of observation						
	Jan. 21	Feb. 8	15th	16th	25th	Mar. 5th	9th
Platform	11	13	12	15	14	9	13
Receiving valve	31	40	29	30	35	32	25
Rest	5	5	5	5	5	4	5
Oviposition	2	3	2	2	3	2	2
Concealing	5	7	5	5	6	4	5
Covering valve	40	50	46	43	41	48	45
Removal of supporting threads	2	3	5	2	2	3	2
Cribellar silk	45	37	46	35	40	49	45
Separation	6	4	5	7	9	7	9
Transportation	1	2	1	2	2	3	1
Total duration	148	164	156	146	157	161	152

Fecundity

Each female *S. sarasinorum* makes a total of 2 to 4 cocoons during her lifetime. The total number of eggs contained in a cocoon varies from 60 to 115, as found in 41 cocoons opened in the laboratory (Table 2). The average number of eggs deposited in each cocoon varies from 67 to 93. The total number of eggs deposited by a single female in her life time varies from 164 to 280. Millot & Bourgin (1942) found that each cocoon of *S. lineatus* contained 150 to 250 eggs. The immature individuals of *S. sarasinorum* that attain maturity late, deposit only few eggs and generally make a single cocoon. A female of this species made a cocoon on 18th January, 1965 in the laboratory, that contained 122 eggs and when this spider was shortly dissected in the laboratory, its ovaries contained 65 more eggs in different sizes within the two ovaries.

Table 2

Number of eggs in 41 cocoons of *S. sarasinorum* Karsch, in 1965

S. No.	Date	No. of Cocoons	No. of Eggs	Average No.
1.	29th Jan.	4	71-115	67
2.	9th Feb.	4	62-115	82
3.	25th Feb.	6	60-114	84
4.	26th Feb.	4	73- 95	87
5.	2nd Mar.	9	77-105	88
6.	10th Mar.	10	66-111	93
7.	23rd Mar.	4	61- 98	83
	Total	41	60-115	67-93

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Notes on South Indian Hepaticae—1[1]

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(With seventeen text-figures)

INTRODUCTION

The bryological flora of south India, a territory luxuriant in liverworts both in frequency and variety, has not received adequate attention. Stray references to some liverworts from this area occur in some publications (reviewed by Pandé & Bharadwaj 1952; Udar 1975).

The leafy genera belonging to acrogynous Jungermanniales, which form the bulk of the hepatic vegetation of south India, have not been studied much. The present paper gives an illustrated taxonomic account of the genera *Trichocolea* and *Notoscyphus*. It is interesting that both these taxa are also commonly found in the eastern Himalayas.

DESCRIPTIONS

1. **Trichocolea tomentella** (Ehrh.) Dumort., Corr. Nees, Naturg. Eur. Leberm. 3:105 (1838). (Figs 1-8).

**Jungermannia tomentella* Ehrhart, Beitrage zur Naturkunde, 2:150. (1788).
Thrichocolea tomentella Dumort., Comment. Bot. 113. (1822).
Thricolea tomentella Dumort., Syllog. Jungerm. 67. (1831).
Tricolea tomentella Dumort., op. cit. p. 99.
Tricholea tomentella Dumort., Rec. d'Observ. Jungerm. 20. (1835).
Trichocolea biddlecomiae. Austin, Bot. Gaz. 3:6. (1878).

Plant whitish green becoming yellowish on drying; stem about 10 cm or more in length, regularly bi-tri-pinnate, dorsally covered with paraphyllia (in the form of simple or branched filamentous cilia), 23-30

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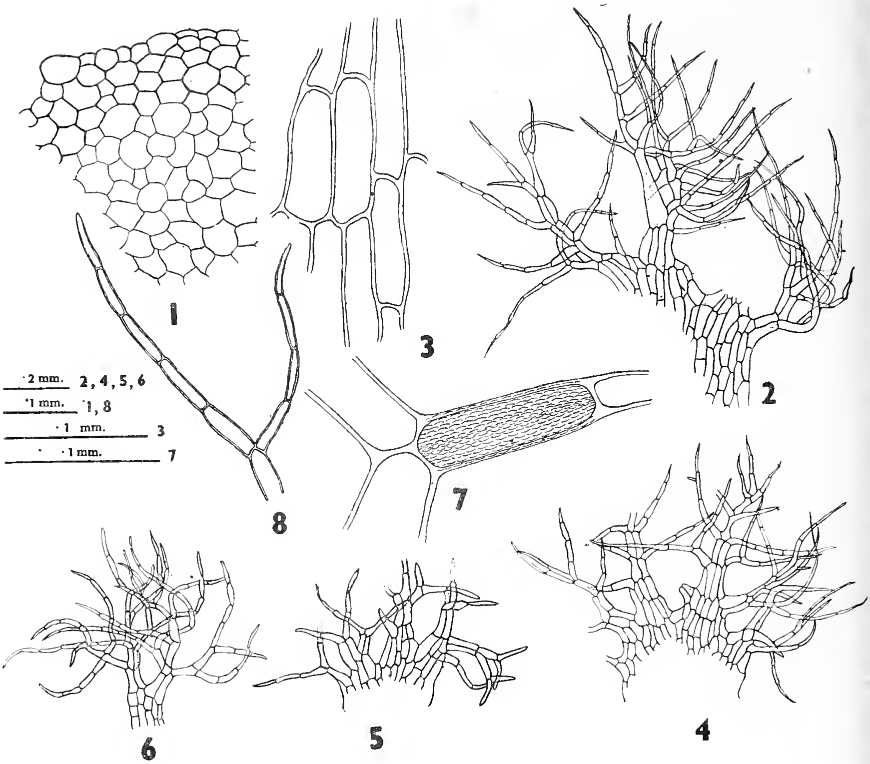
[1] Accepted July 1971.

* Synonymus adopted from Hatcher (1957).



Trichocolea tomentella

Fig. 1. Cross section of stem (a portion magnified); Fig. 2. Leaf of the main axis; Fig. 3. Cells of the leaf lamina; Fig. 4. Underleaf of the main axis. Fig. 5. Leaf of a branch; Fig. 6. Underleaf of a branch; Fig. 7. Cells of the cillia magnified; Fig. 8. Branched paraphyllium.

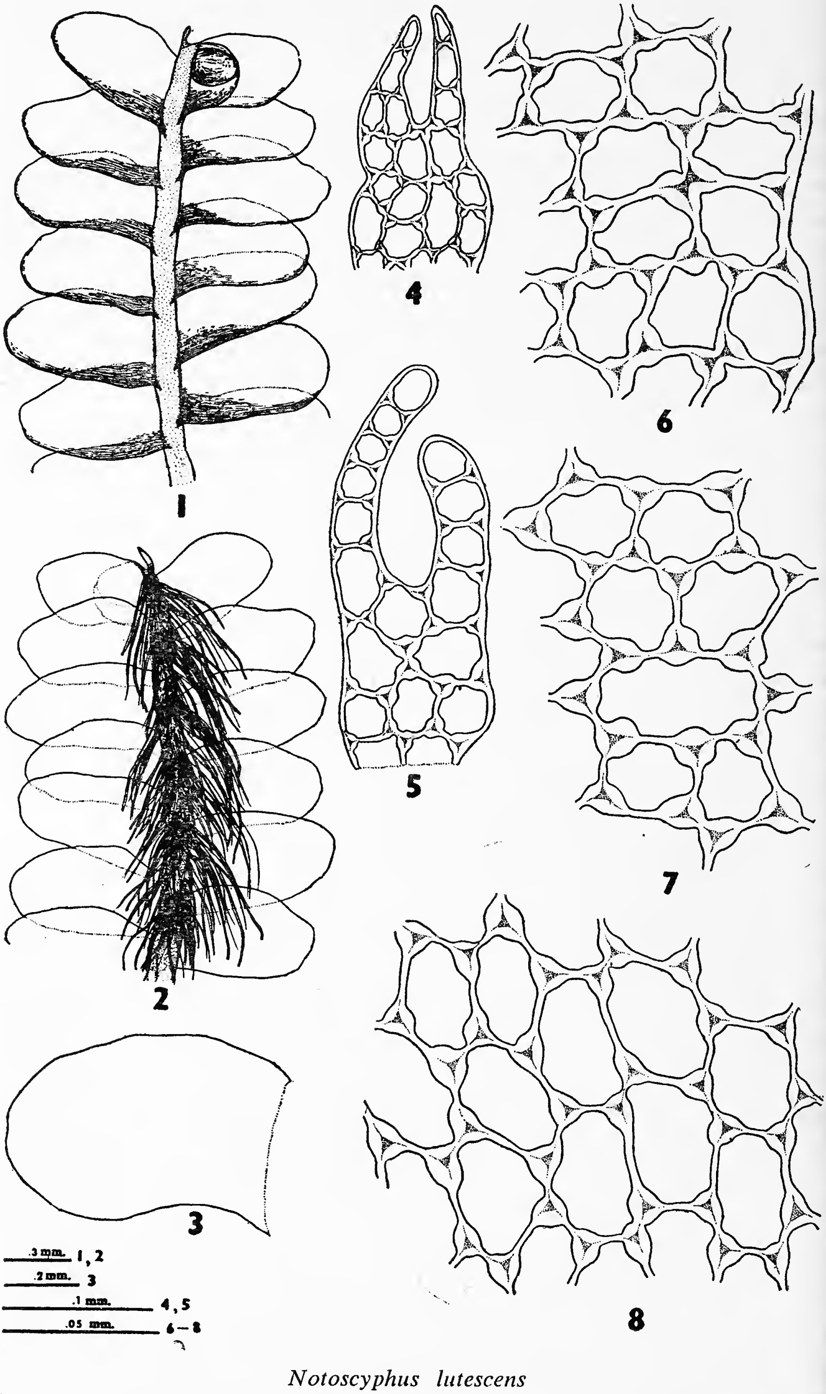
cells across diameter, cells differentiated into cortex and medulla, cortical cells 9.6-38.4 μ in diameter, with slightly thickened walls, medullary cells not thickened, 24-52.8 μ in diameter. Leaves in three rows, two lateral and one ventral, lateral leaves alternate, about 1.5 mm or less long, (from the base to the apex of the cilia), 1.7 mm broad, deeply divided into 6-8 (usually 6) segments with simple or branched cilia, cells of the cilia 57.6-105.6 μ long, 9.6-24.0 μ broad, cuticle striolate-papillose; cells of the undivided lamina 67.2-124.8 μ long, 19.2-28.8 μ broad; underleaves smaller than the leaves, *c.* 1 mm long, 1.5 mm broad, bifid, each lobe further divided into 4-6 simple or branched cilia similar to those of the leaves. Male inflorescence branched, antheridial branches similar to that of the vegetative branches; bracts concave,

similar to that of the leaves, occur in series; antheridia large, stalked and globose, solitary or in pairs in the axils of bracts; bracteoles similar to that of the underleaves. Female inflorescence terminal on the main stem or branch, perianth absent, archegonia clustered at the apex protected by three series of bracts and bracteoles, the inner most series of bracts and bracteoles larger than the rest of the outer series; bracts apparently similar to that of the leaves and bracteoles to that of the ventral row of leaves. Sporophyte enclosed within a club shaped coelocaule (shoot calyptra), capsule large, oblong, dehisces in to 4 valves; capsule wall 6-7 cell layers thick, cells of the outer layer large and thin-walled, cells of the inner layer small with rod shaped thickening bands on the tangential wall. Elaters reddish-brown 117 μ long, 10 μ wide with 2 spiral bands and rounded tapering ends.

The plants investigated in the present work were collected by Rev. I. Pfleiderer (of Esslingen, Germany) from Kudremukh, south India. The study was further supplemented from fresh collections made by the authors from Palni Hills in south India in December-January, 1965 and from Darjeeling in eastern Himalayas in December-January 1969-70.

T. tomentella has a characteristic feathery appearance in nature. It grows on moist rocks in dense overlapping tufts either in pure formation or occasionally mixed with other hepatics and mosses. Unfortunately the specimens from south India and eastern Himalayas are not fertile. The account of male and female inflorescence given in the taxonomic description is based on contributions made by Hatcher (1957, 1959) on the genus *Trichocolea* from America.

The development of fruiting structure in *Trichocolea* is of three distinct types (Hatcher 1959). In *T. tomentella* "fertilization and the beginning of development of the young sporophyte apparently stimulate the formation of a broad meristematic zone of stem tissue between the base of the fertile archegonium and the point of insertion of the inner most series of bracts." After fertilization of one of the archegonia which are clustered at the apex, the young developing sporophyte grows downward into the stem tissue and gets differentiated into an haustorial foot, a seta and a capsule. In the meantime the stem tissue which surrounds the developing sporophyte, grows upwards completely enclosing the young sporophyte. This covering of the thick-walled stem tissue which surrounds the sporophyte was termed coelocaule (Goebel 1930; Knapp 1930). The outer surface of the coelocaule is stated to be densely clothed with paraphyllia. The coelocaule is surrounded by bracts and bracteoles below, while at the top of the coelocaule numerous unfertilized archegonia are found. On maturation of the sporophyte, seta elongates and the tip of the coelocaule ruptures irregularly by the emergence of the large, oblong capsule. The spores in this genus are reddish-brown, 30-35 μ in diameter, oval to rounded, smooth or minutely punctate.



Notoscyphus lutescens

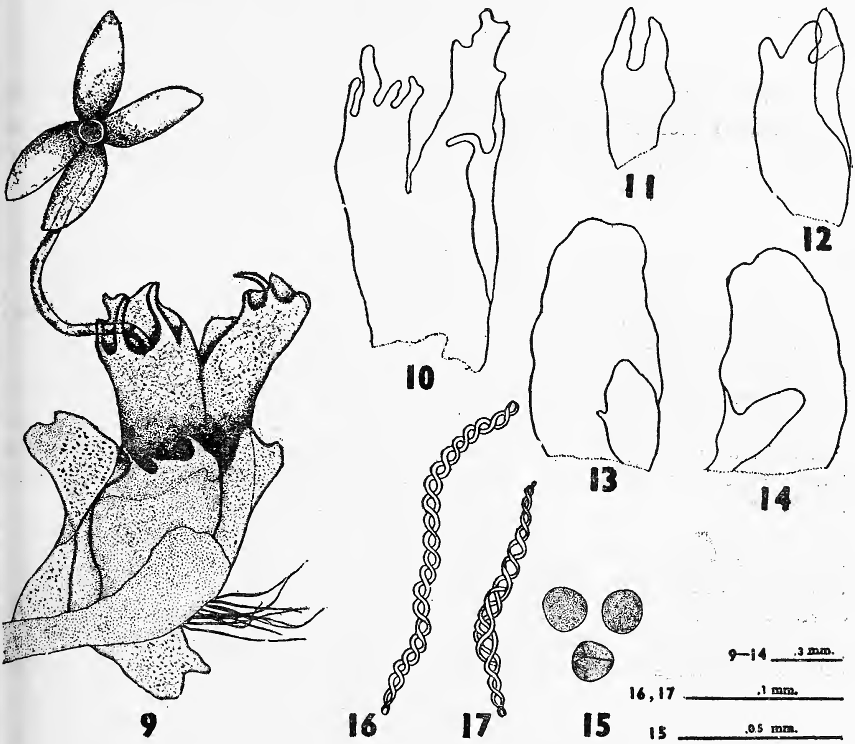
Figs. 1-2. Dorsal and ventral niew of the plant respectively; Fig. 3. Leaf; Figs. 4-5. Underleaves (amphigastria); Figs. 6-8. Marginal, middle and basal cells of the leaf respectively.

2. **Notoscyphus lutescens** (L. et L.) Mitt. Fl. Viti, p. 407, 1862. (Figs. 1-17).

**Jungermannia lutescens* L. *et* L., Pug. IV p. 16 (1932).

Gymnomitrion lutescens G., Syn. Hep. 4 (1844).

Plants small 10-18 mm or so long, prostrate, green to yellowish-green, rarely branched; rhizoids ventral, arising in fascicles from the base of the amphigastria. Leaves in three rows, two lateral and one ventral; lateral leaves simple, succubous, entire, unistratose, cells with conspicuously bulging trigones, oil bodies in fresh leaves 2-4 per cell, elliptical, prominently granular with rough outline, apical cells of the leaf 19.2-28.8 × 38.4-48.0 μ, middle cells 19.2-28.8 × 24.0-57.6 μ and basal cells 24.0-38.4 × 28.8-48.0 (52.8) μ; underleaves minute, bifid, *c.* 264.0 μ long, 100.8 μ broad, cells with conspicuously developed trigones. Dioecious. Antheridia in the axils of the bracts, bracts sac like in two



Notoscyphus lutescens

Fig. 9. Magnified view of the perianth with elongated seta and dehisced capsule; Fig. 10. A portion of the perianth; Figs. 11-12. Female bracts; Figs. 13-14. Male bracts; Fig. 15. Spores; Figs. 16-17. Elaters.

* Synonyms adopted from Arnell (1963).

alternate rows enclosing a single antheridium in each. Archegonia apical, enclosed within the perianth, bracts and bracteoles bifid, sporophyte differentiated into foot, seta and capsule, seta elongated bearing a spherical dark-brown capsule, capsule dehiscence into 4-valves, capsule wall multistratose, cells with thickening bands; spores unicellular, more or less spherical *c.* 12.0-14.4 μ in diameter; elaters tapering at both ends, usually bispirate, rarely with a tendency to become trispirate, 67.2-249.6 μ long and 9.6-14.4 μ broad in the middle.

The plants were collected by us from Kodaikanal (alt. 6500 ft, Palni Hills), south India in December-January 1965-1966. This species also grows abundantly in east Himalayan territory. The study of the oil-bodies was completed from the specimens collected from Darjeeling during December-January 1969-70 (Udar *et al.* 1970).

Acknowledgements

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The Terrestrial Mammals of Bahrain[1]

Michael Gallagher[2] and David L. Harrison[3]

(*With a map*)

Introduction

A summary is given here of 13 species of terrestrial mammals which occur in Bahrain, in the Persian (Arabian) Gulf, based upon the identification by Harrison of specimens collected by Gallagher during the latter's residence on the island from December 1968 to July 1971, and during a visit in April 1974, supplemented by field observations and reports in the literature. Eight species are recorded for the first time from the Bahrain Islands.

No other systematic account of Bahrain's mammalian fauna has been published, and as changes are inevitable under pressure from an expanding human population future assessments may be measured against this brief account.

Bahrain

The independent State of Bahrain is an archipelago of about 30 small desert islands at the entrance to the V-shaped Gulf of Salwa (*Dowhat al Salwa*) mid-way along the Arabian shore of the Persian or Arabian Gulf. The largest of the group is Bahrain Island, some 30 miles in length from north to south, 10 miles at its broadest and with its centre at 26°03′N, 50°33′E. It is connected by causeway with Muharraq Island, on which is the international airport, and by a short bridge and a new causeway with Sitra Island and its oil terminal. Other islands on the east side include Nabi Salih and, near the shore of the Qatar peninsular, the Howar group; on the west side are Umm Nassan, Jidda and Umm Saban.

The greater part of Bahrain and its satellite islands is a desert of

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[3] Bowerwood House, St. Botolph's Road, Sevenoaks, Kent, England.

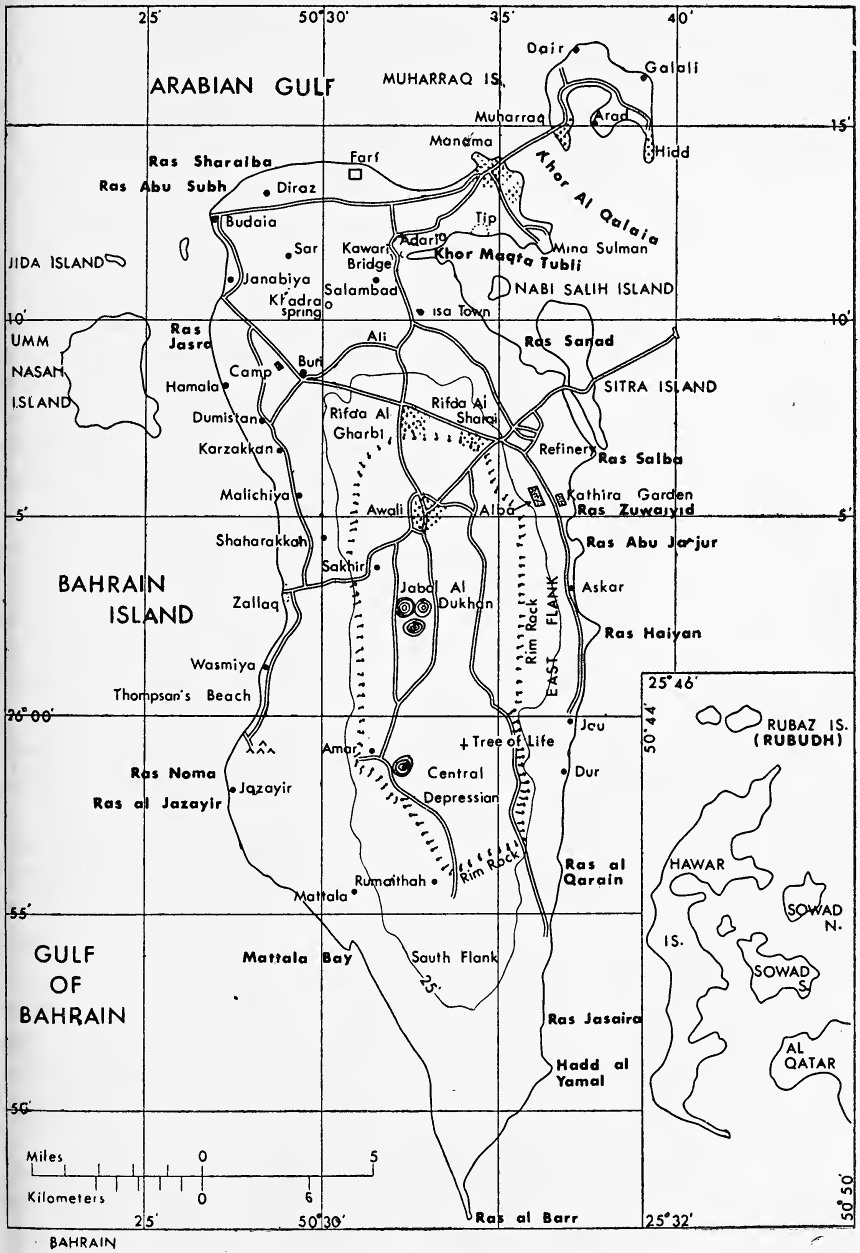
sand, stones and rock. Bahrain Island itself is an elongated dome, principally of Eocene limestone, parts of which have slumped and eroded to form dusty depressions bordered by low cliffs and hills. The Jebel al Dhukhan, at 440 feet the highest surviving part of the original dome, stands in the central, saucer-like depression. The stony flanks slope outwards and downwards to the peripheral extension of recent deposits, mostly of sabkha (salt mud flats) but also of silt, blown sand and raised beaches; only in one place (at Ras Noma, south of Zallaq on the west coast) is there an area of medium-sized dunes, though this is not extensive. In some of the larger wadis (dry water courses) cut in the west flank, deposits of windblown sand against the wadi walls produce near dune conditions, with rocks, bushes and sand hummocks in the wadi bed. There are some caves and many niches and crevices in the limestone sheets, hills and cliffs.

Howar Island, the largest of the group 13 miles south east of the southern tip of Bahrain Island, is 12 miles from north to south but only 3 miles at its broadest. It is uninhabited except for half a dozen policemen who live in the fort near a deserted fishing village at the north west tip and have one landrover, but it is occasionally visited by fishermen, and also by picnic parties who stay at the guest house near the north east tip. It consists mainly of an uneven limestone plateau, which slopes up from raised beach flats in the west to end as 30 foot cliffs on the east side. Some variety on this bleak desert island is provided by much flotsam cast up on the north and west coasts, by two small elongate hills with eroded niches used by animals for shelter, by sand-filled wadis and shallow depressions and by traces of old cultivation.

Vegetation occurs over most of the islands (Good 1954, 1955 and Wiltshire 1964), but in all except the irrigated part of the northern cultivated zone it consists of hardy xerophytic and sub-halophytic species, improved and supplemented by carpets of ephemerals after heavy rain. There are numerous plant species suitable for herbivores, but these are patchy in distribution.

Cultivation, mostly in date gardens, is restricted by the availability of water to a narrow discontinuous belt which stretches in an arc from near Zallaq on the west coast of Bahrain Island to Sitra on the east, and to parts of Muharraq, Sitra and some smaller offshore islands. Most of the available water seeps slowly along pervious strata from Saudi Arabia in the west and is tapped by hundreds of artesian wells or emerges as land and submarine springs; it is supplemented by some water which accumulates from local rains. The salinity increases and the static head decreases from the north-west to the south-east and supplies are dwindling rapidly and becoming more saline. The lowering of this water table has, over the years, caused some springs to cease or reduce their flow and the ancient subterranean aqueducts (*qanat* in Bahrain and Iran,

the equivalent of *falaj* in Oman) to dry up. Nevertheless there are still some brackish wells in use in the southern part of the island for the watering of domestic animals. On Howar Island there are at least three cisterns for the collection of rain water; these were full in April 1974



Map of Bahrain Island.

but only one has an access for animals. The domestic oil town of Awali, in the desert, has its own water supply and flora.

The harsh desert climate is modified by the surrounding sea and the prevailing north-westerly wind (*Shimaal*) and is less severe than on the Arabian mainland, temperatures varying (in the 20-year period 1947-1966) between extremes of 39°F in winter and 113°F in summer; cold, stormy conditions can occur in winter and periods of unpleasant humidity in summer. Rainfall is very variable, averaging 75 mm over the same period, but there was a peak of 165.9 mm in 1969 and the resulting improvement in the vegetation was long-lasting.

Mammalian fauna

As is to be expected on small desert islands, the number and variety of species on the Bahrain islands is limited. Up to April 1974 only thirteen terrestrial mammalian species have been identified from the wild with certainty; these are: one hedgehog and one shrew (Insectivora), three bats (Chiroptera), one mongoose (Carnivora), one gazelle (Artiodactyla), one hare (Lagomorpha) and five small rodent species (Rodentia). Eight of these had not been reported from the Bahrain islands previously, but this is more probably due to the fact that no systematic collecting had been attempted previously, rather than to the recent introduction and naturalisation of all the species. The discovery on Bahrain Island of the Iraq race of the Naked-bellied Tomb Bat *Taphozous nudiventris,* its most southerly record, is of interest, as is the existence of a distinct race of the hare *Lepus capensis* endemic to Bahrain Island. The local hedgehog *Paraechinus aethiopicus* also exhibits at least one characteristic which may, when more material has been studied, show that it has evolved as a separate race.

There appear to be no foxes or wild cats, though at least one of the cat skulls found on Bahrain Island is very probably that of the Arabian Wild Cat *Felis silvestris.* The absence of such species, which occur on the neighbouring mainland, is not surprising, for even if they had once occurred they would be unlikely to survive for long.

On Howar Island in April 1974 the sand rat *Meriones crassus* was found. Other species seen there were gazelle *Gazella subgutturosa,* the hare and Brown Rat *Rattus norvegicus;* a skull of the Common Mouse *Mus musculus* was found. Two Wild Goat *Capra aegagrus* were brought to the island in 1973, but later killed.

The apparent absence of other bats and smaller desert animals such as the gerbils *Gerbillus* spp. is less understandable, for conditions in some parts of the islands would seem suitable and more species may well be found.

ORIGINS

The Bahrain Islands began emerging from the sea near the close of the middle Miocene, and further local uplift in the late Miocene and Pliocene, followed by much weathering, gave the islands their present configuration (Willis 1967), though the sea level at the end of the Pliocene was probably 150 m higher than at present (Fairbridge 1961, *in* Kassler 1973).

Kassler (1973) has shown that from about 80,000 years ago the sea began to retreat, and that from about 70,000 to 17,000 years ago, during the maxima of the Pleistocene glaciations, the Gulf was almost wholly exposed in the form of a very large river valley.

The sea returned in stages to its present level about 5,000 years ago, the last two stages entered the Gulf of Salwa, cutting marine platforms at 18 m and 9 m present depth, approximately 8,000 and 7,000 years ago. There are, however, some marine deposits in the Gulf of Salwa which are 11,000 years old. Bahrain was therefore probably connected with the mainland from about 80,000 to 11,000 (or 7,000) years ago, during which time vertebrate fauna from the mainland must have occupied suitable niches in the Bahrain ecosystem.

The Bahrain Islands now lie wholly within the 18 m depth contour and are joined to the mainland of Qatar and Saudi Arabia by a narrow structural feature, known as the Bahrain Ridge, over which the water depth is less than 9 m. To the south in the Gulf of Salwa is a shallow depression in the sea bed formed by subsidence early in the Pleistocene period. The Bahrain Ridge has been rising in the last few thousand years and marine growth and deposits have caused very shallow conditions around Bahrain. It has been suggested (A. J. Standring, in pers. comm. to Gallagher) that it is not impossible that temporary shoal development, combined with exceptionally low tides, could have produced short lived connection with the mainland sufficient to permit the migration of some species after the flooding of the Gulf of Salwa. The distance (some 20 miles to Qatar from Bahrain Island across the shallower part of the Ridge), and the tidal regime, would seem to make this only a remote possibility, except perhaps for gazelle, which are known to wade in search of marine algae. It is said that it is now possible for a man to wade at low tide to some Howar islands from Qatar.

It is considered that 2,000 to 3,000 years would have been required for the hare to have developed its distinct morphological characters; the length of Bahrain's isolation indicated above would have provided the necessary time. The shrew *Suncus murinus,* mongoose *Herpestes edwardsi,* gazelle and some rodents have probably been introduced or reintroduced by man, but the hedgehog, hare, jerboa *Jaculus jaculus* (not *Meriones* as given by Wiltshire) and many reptiles (Gallagher 1971)

have probably been present since Bahrain became isolated. Wiltshire (loc. cit., p. 121) also says that the presence of the *Uromastyx* lizard and the jerboa "suggest that Bahrain was formerly united with the mainland and has never been entirely submerged, to the detriment of its desert fauna, since that union".

Threats and conservation

The increase in the human population (to over 216,000 in April 1971, representing an increase of nearly 3 per cent annually since the previous census in 1965), and the continued improvement in living standards, have led to greater mobility; to a spread of urbanisation, of factories and of roads; to the neglect of some plantations, and to an increased demand upon the natural resources of the island, such as oil, gas, water, stone and sand for construction, and generally wider facilities for recreation. These factors have increased the pressure upon the countryside and, to a greater or lesser degree, upon the fauna and flora.

It is pleasing to be able to report that H H the Amir has continued to deny the general public access to the southern half of the island unless special permission is obtained. This was formerly the reserve for the hunting by the ruling family, by falcon or Saluki hound, of game birds, particularly the Houbara *Chlamydotis undulata,* the hare and possibly the gazelle. Due probably to the scarcity of the first two such hunting is now rarely practised, but the area is regularly traversed by staff of the Bahrain Petroleum Company (BAPCO) as it lies over the oil and gas fields; fishermen and weekend picnic parties are occasionally permitted to enter and to drive anywhere.

The killing of gazelle and hare is forbidden everywhere, but the shooting of hare is known and both these and other species, such as the jerboa and mongoose (and the lizard *Uromastyx microlepis*) are killed by traffic, particularly in Spring. However, such species as the rats *Rattus* spp., Common Mouse and shrew will probably benefit from further urbanisation.

Apart from Man the predators of mammals probably include feral dogs and cats; some birds, mostly migratory (Rogers & Gallagher 1973), and the resident terrestrial snakes (Gallagher 1971). In 1974 tracks of large feral dogs were seen in the desert which would indicate an extension of their range.

SYSTEMATIC LIST

Order Insectivora

Family Erinaceidae

Paraechinus aethiopicus Ehrenberg, 1833. Ethiopian Hedgehog

1 ?o, 21 March 1970, near Zallaq.

1 ?o, 29 July 1970, between Nuwaidrat and Malamir.

In or near cultivated or well vegetated areas, including Muharraq Island, but rarely seen. Reported in January, March, April and July, usually on roads, so it is probably active throughout the year.

This is the first record of the species on Bahrain (Harrison 1972). The sides of the carapace of the two specimens are noticeably whiter than other examples of this species from Arabia in the Harrison collection and described in Harrison (1971). These specimens may well represent a local race, but more material is required to determine the constancy of this character.

Family Soricidae

Suncus murinus Linnaeus, 1766. House Shrew or Grey Musk Shrew

1♀, 18 April 1970,	near Manama
1♂, 2♀♀, 6 May 1970,	" "
2♂♂, 2♀♀, 5 June 1970,	" "
1♂, 1♀, 1 September 1970,	" "
1♂, 1♀, 29 September 1970,	" "
1♀, 20 May 1970,	Awali.

The first record of *Suncus* in Bahrain was a very small female, found dead by T D Rogers on the soil covering the municipal rubbish tip near Manama. Despite many subsequent searches both here and elsewhere only the larger, more common form was found. The very small size and the different dentition of the first specimen make it probable that either the smaller form represents an additional introduction from the Orient or that *S. murinus* is a polymorphic species.

Almost entirely nocturnal, it was very common and noisy on the rubbish tip in May 1970, but was rather less common at other times and it seemed to be absent in the cold months. It also occurs quite commonly in and around some houses and gardens near Manama, where it has been recorded climbing the creeper on houses, and it has also been recorded at Awali. Also called the Blind Rat, and known by some Iranians on Bahrain as *musha*, some locals believe them to be poisonous.

Order Chiroptera

Bats were seen in the cultivated zone of Bahrain and Muharraq

Island most of the year. Three species were indentified, but the roots of only two were found and these could not be checked regularly.

Family EMBALLONURIDAE

Taphozous nudiventris magnus Wettstein, 1913. Naked-bellied Tomb Bat

5♂♂, 1♀, 10 June 1970, Qala'at al Bahrain.

1♀, 12 July 1971, near Tubli.

These specimens are the first record of this species on Bahrain and the most southerly record of the Iraq race (Harrison 1972).

The largest bat seen on Bahrain, they usually fed in the clearings between date plantations. Only one roost was found, in the roof of a tower of the Qala'at al Bahrain (the "Portuguese fort") on the north coast; no other species were seen to share this roost, which was not occupied all the year; very few were present there in April 1974.

Family HIPPOSIDERIDAE

Asellia tridens Geoffroy, 1813. Trident Bat

4♂♂, 6♀♀, 5 July 1970

4♂♂, 3♀♀, 17 November 1970

2♂♂, 2♀♀, 15 January 1971

A fairly common species, of which three roosts were found. The first, on 5 July 1970, was of about 20 bats in a subterranean aqueduct (*qanat*) near the village of Malichya, at the foot of the west flank. These qanat have open man-holes reaching to the surface, like wells, every 20 metres or so, through which the bats fly. Very little dung was present, indicating that this roost is not in regular occupation; no bats were present on 10 December 1970, 26 April 1974, nor on some other occasions.

The second, on 17 November 1970, was in a series of caves reached by a very small tunnel leading from the south face of the historic fortified hill near the settlement of Amar, in the centre of the southern half of Bahrain Island. About a hundred bats seen before they fled down other passages. A huge bank of dung and a very strong smell were evidence of undisturbed occupation over a long period.

The third roost was in a natural cave in the limestone of the east flank, about two kilometres south of the village of Askar. The mouth of the cave was partly walled round, suggesting that it was used as a cistern to collect rain water. The large outer cave is connected to some smaller ones, and in a hollow about 3 metres by 2 metres in one of these about 60 bats were found on 15 January 1971, but only about six bats were present on 27 May 1971.

Although a widely distributed species and known from neighbouring

Qatar and from Hufuf, eastern Saudi Arabia, these were the first records from Bahrain (Harrison 1972, p. 627).

Pipistrellus kuhli ikhwanius Cheesman and Hinton, 1924. Kuhl's Pipistrelle

1♀, 4 May 1971, near Manama.

This specimen was taken by T D Rogers at 8 p.m. from amongst many small bats flying in clearings between date gardens at the edge of the marshes near Manama. Small bats, possibly this species, were widespread in the cultivated zone of Bahrain and Muharraq islands, and they were said to be found occasionally on trees as well as buildings.

A widespread species, it was known from Bahrain previously from two specimens in the Cox-Cheesman collection and collected on 9 April 1921 (Cheesman & Hinton 1924, and Harrison 1964, p. 155).

Order Carnivora
Family VIVERRIDAE

Herpestes edwardsi ferrugineus Blanford, 1874. Common Mongoose

1♀, 2 November 1969

1♂, 30 March 1970

1 ?o, 4 June 1970 (skull only) Malichiya

A successful species, presumably introduced from Iran or India, and known from the cultivated zone, where it is widespread and even occurring in the capital (Mandaville 1971) and once at Awali, where at least one was kept in captivity and later released (I W Hanwell, in pers. comm.).

They live in burrows, drain pipes, holes in the wall etc., and are active throughout the year, foraging singly or in family parties in and near gardens and digging in lawns. The food includes snakes, chickens, eggs and young birds (Belgrave 1953) as well as Coleoptera larvae and possibly rodents, the Marsh Frog *Rana ridibunda* and the eggs of the Terrapin *Clemmys caspica*.

Copulation was reported only at the end of January and in February, though in India the species breeds throughout the year (Prater 1971).

Both specimens were found by Mrs C Stroud killed by traffic on the north coast road. These are the first mongooses to be recorded from Bahrain (Harrison 1971).

Family FELIDAE

Felis spp.

1 ?o, 12 July 1970 (skull only), Ras al Qarain.

1 ?o, 15 January 1971 (skull only), near Askar.

There is no certain record of wild cats having existed on Bahrain.

However, two very large cat skulls were found, one near the beach about 6 km south of the almost deserted village of Durr on the east. coast, and the other with some remains of the animal in the bat cave near Askar. They are not *F. margarita,* but they are quite possibly genuine Wild Cat *F. silvestris.* The first could just possibly be from a feral animal, but the second skull and teeth closely match other specimens of *silvestris* in the Harrison collection; it is however, impossible to be certain without the skin.

One of these might be from a "*Felis lybica* (= *F. silvestris*) from the Ethiopian frontier and released by a friend" in 1969 (R W B Izzard, in pers. comm.).

Mr L D Josephson (later of BAPCO) said, in pers. comm. in 1971, that "a lair of two wild cats in the Bahrain desert was reported in the *Bahrain Islander* (a BAPCO journal) about 15 years ago", but this report has not been traced. Some residents in 1974 said that they had seen large cats, but these animals may be feral domestic cats, of which there must surely be a number.

Order Artiodactyla
Family Bovidae

Gazella sp.

Gazelle, apparently all *Gazella subgutturosa* (see later), wander freely over the southern part of Bahrain Island and they have been recorded as far north as Hamala Camp. They often frequent the coasts, usually leaving early in the morning; they also visit Jebel al Dhukhan when water and vegetation is available. The maximum number seen together was 27 (on 13 August 1971, west of Amar, by M C Jennings, in pers. comm.). Young have been seen with adults in spring and a freshly dead juvenile was found in July 1971. Formerly hunted with Saluki hounds and falcons, they are now protected but are occasionally killed by traffic. Some have been reported being drowned in the sea after bolting to escape from helicopters.

Their origin and present status is not clear. Even if there was an indigenous stock it must have been increased by gifts to the Amir and by escapes from the small captive herds kept by some sheikhs.

Gazelle on Howar Island could have been introduced or might have waded from the mainland of Qatar at very low tide. Seven were seen on Umm Nassan Island on 18 April 1970, where there was also a large Blackbuck *Antilope cervicapra* on 27 December 1970, no doubt introduced. About twenty gazelle are said to have been introduced to Umm Nassan from India by Sheikh Hamad, the grandfather of the present Amir. Two Wild Goat were introduced briefly to Howar Island in 1973.

Gazella subgutturosa marica Thomas, 1897. Rhim Gazelle

1 ?o, 12 July 1970, Ras al Qarain

1 ?o, 26 July 1971, Ras Noma

1 ?o, 28 July 1971, Wasmiya, Zallaq

This race was represented from Bahrain by a single specimen in the British Museum (Natural History) collected in 1922. The head from the whole mummified remains of a very immature gazelle, found behind the beach crest on the south east coast, was therefore the first example of this species obtained on Bahrain for nearly fifty years.

Two other young gazelle of this species were found dead on the road near Zallaq on the west coast but, as for the first specimen, only the skulls were retained.

About ten gazelle are said to survive on Howar Island, where at least three were seen regularly at a water cistern and vegetation near the Police Fort in April 1974; resting places were found under rock ledges in the jebels near the centre of the island. The skull of one found dead in a cistern by J H Clingly in 1973 proved to be this sub-species. Mr Clingly says that he believes that it is they that make the small excavations to be seen along the beach crest, and it is presumed that this is in a search for the basal tubers of *Cistanche lutea* (Orobanchaceae) which flower there after Spring rains.

Order Lagomorpha

Family Leporidae

Lepus capensis atallahi Harrison, 1972. Bahrain Hare

1 ♀, 14 April 1971, near Isa Town

1 imm. ?o, 29 July 1970, Khadra. BM (NH) No. 1970.2035

1 ♂, 12 May 1971, Ras Noma

This very small hare, distinguished from all other Arabian hares by its remarkably short ears, was first described (Harrison 1972) from a specimen found dead on the road near Isa Town by T D Rogers. A leveret, found alive by M C Jennings on 29 July 1970 and killed by a dog on 5 August, is in the British Museum (Natural History) spirit collection, and another leveret, taken in the dunes at Ras Noma on 12 May 1971 by Capt D M Dever, is in the Harrison collection.

With the rapid spread of urbanisation and main roads the hare is not as widespread and as common as it was (Belgrave 1953). However, it is still present in most desert areas, including Jebel al Dhukhan, as far north as Isa Town, as far south as the southern tip and on the east and west coasts. One was also seen on Umm Nassan Island on 27 December 1970 and it was present on Howar Island in 1974. Hunted formerly with Saluki hounds it is now protected, but is occasionally shot, and also killed by traffic.

It is mainly crepuscular or nocturnal, and avoids the heat of day by

lying in a shallow form under a bush or rock, or in a burrow of about its own length dug into the sand at the base of a bush, from which it will tend not to move unless approached very closely.

The specimen found on 14 April was host to the sucking lice (Phthiraptera) *Haemodipsus setoni* group Anophira: Hoplopeuridae, the first recorded example from this species.

Order Rodentia
Family Dipodidae

Jaculus jaculus vocator Thomas, 1921. Lesser Three-toed Jerboa

1 ?o, 7 February 1969, Sakhir

1 ?o, 23 March 1969, Central desert

1 ♀, 1 December 1969, Central desert near Awali

1 ?o, 12 February 1970, Central desert

1 ?o, 22 August 1970 (skull only) Wasmiya

1 ♀, 20 November 1970, Central desert

1 ?o, 20 February 1971 (skull only), near Malichiya

1 ?o, 3 March 1971 (skull only preserved), Sitra

Widespread in desert and semi-desert, and occurring as far north as Budaia. It is active during all but the cold months, though it may not be seen so frequently in mid-summer.

The burrow is not easily found, presumably because it is usually on flat open ground and the animal usually seals it from within. At Rifa'a boys are said to catch them after pouring water down the burrow. After heavy rain one jerboa was found dead outside a small burrow 10 metres up on a small hillside near Sakhir. Most other specimens have been found killed by traffic on the roads.

One previous specimen from Bahrain is in the British Museum (Natural History) collection (Ellerman 1948).

Family Muridae

Rattus rattus Linnaeus, 1758. Black Rat

1 ♂, 13 February 1970, Jufair, near Manama

1 ♂, 25 February 1970, near Manama

1 ♂, 3 March 1970, near Manama

1 ♂, 8 March 1970, Manama

1 ?o, 22 August 1970, coast at Ras Jazayir

3 ♂♂, 18 September 1970, Khadra

1 ?o, 25 September 1970, Nakhl Lozi, near Buri

1 ♂, 9 November 1970, Jufair

1 ?o, 5 April 1971, Budaia

Widespread in habited and vegetated areas and in semi-desert. Specimens, all of the pale form, have been seen in most parts of the northern

half of Bahrain and on Muharraq Island; tracks, probably of this species, were found on Jebel al Dukhan and on all beaches, so that it may exist over the southern half also. They commonly climb trees by day and night. The specimen on 5 April was found in the gut of a snake *Coluber ventromaculatus*.

Two specimens were host to the Sucking Louse (Anoplura) *Polyplax spinulosa* (Burmeister 1838) and one to a tick *Hyalomma* sp. (probably *impeltatum*).

Earlier specimens from Bahrain are in the British Museum (Natural History) collection (Harrison 1972, p. 460).

Rattus norvegicus norvegicus Berkenhout, 1769. Brown Rat

1 ?o, December 1968, (skull), Ras abu Jarjur
1 ♀, 23 August 1969, Jufair, near Manama
1 ♂, 25 August 1969, Jufair, near Manama
1 ?o, 30 August 1969, Ras Noma
1 ♂, 1 January 1970, near Manama
1 ♂, 7 November 1970, Muharraq causeway
1 ad. ♀, 1 imm. ?o, 16 April 1974, Howar Island (skulls retained)

It occurs around the harbour and habited areas of Muharraq Island and of Bahrain Island, certainly as far south as Sitra and Ras Noma.

The specimens collected are the first to be recorded from Bahrain (Harrison 1971, and 1972, p. 465).

Discovered for the first time on Howar Island near the old village and police fort. Skulls were also found in bird pellets from the centre of the island, and burrows were seen in debris and dry seaweed along the west coast.

The Howar specimens were host to the mite *Laelaps nuttali* Hirst.

Mus musculus gentilulus Thomas, 1919. Common Mouse

Very common and widespread over most of the islands, where it has been taken in domestic areas, under vegetation, in pure desert and on beaches. The burrows are in or at the base of sand hummocks, under vegetation or on flat ground (as on some beaches); some are sealed from within. Entirely nocturnal.

One had been swallowed by a snake *C. ventromaculatus,* and one on 31 May contained four embryos. The skull of one was found in an old pellet of a predatory bird on Howar Island in April 1974.

An earlier specimen from Bahrain is in the British Museum (Natural History) (Harrison 1972, p. 474).

Family Cricetidae

Meriones crassus crassus Sundevall, 1842. Sundevall's Jird

2 ♂♂, 17 April 1970, Howar Island, Bahrain

These specimens came from burrows under rocks on the plateau at

the north of the island. Others were seen in a colony of burrows in sandy hummocks and soft ground under bushes near the west coast, and other rodent burrows, possibly of this species, were in rocky and sandy ground in other parts of the island.

In subsequent searches of similar ground on Bahrain Island the lizard *U. microlepis* was found to occupy most likely sites. However, *Meriones* may yet be found to occur in parts of that island also.

These are the first specimens from the Bahrain Island. The nearest previous examples came from Al Khobar, 26 miles west of Bahrain Island. The specimens resemble series of the typical form from Sharjah, on the mainland, in all essential respects.

These specimens were host to the mites *Androlaelaps longipes* (Bregetova); an association with *Meriones* species was noted by Bregetova (1952) in USSR and Costa (1951) in Israel.

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Food-habits of water-birds of the Sundarban, 24 Parganas District, West Bengal, India—V[1]

Lapwing, Sandpiper, Stint, Tern, Kingfisher

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(*With three text-figures*)
(*Continued from Vol. 71*(2):200)

Vanellus indicus indicus (Boddaert), The Red-wattled Lapwing

The Red-wattled Lapwing, *Vanellus indicus indicus* (Boddaert), is a common bird of the Sundarban area. It is generally met with singly or in pairs. In the reclaimed area it is found in cultivated fields especially after harvesting, on elevated bunds between such fields when these are inundated, as well as in fallow lands, edges of freshwater pools, tanks, etc. In forested area, it is sometimes seen on exposed mud-flats of tidal rivers and forest fringes, and sometimes near pools of water in the interior.

About the food-habits of the Red-wattled Lapwing, Jerdon (1864, p. 648) remarked that it feeds on various insects, shells, and worms. Mason & Lefroy (1912, p. 265) examined the food of nine examples at Pusa (Bihar) and stated: "Of 118 insects taken by 9 birds, 51 are injurious; 6 birds took injurious insects, 4 neutral and 4 injurious. One bird took a prawn, 1 shell and 2 vegetable matter". Baker (1929, p. 188) writes that its food consists of worms, grubs, insects of all kinds as well as freshwater mollusca, tiny crayfish, etc. Ali (1955, p. 92) found that it fed on insects, grubs, molluscs, etc.

On an examination of the stomach-contents of 69 specimens of the European Lapwing, *Vanellus, v. vanellus* (Linnaeus), Collinge (1927, p. 234) found that of the total food consumed during the year 89 per cent was animal food. Of this, injurious insects formed 60 per cent, neutral insects 4 per cent, slugs and snails 10 per cent, earthworms 10 per cent, and miscellaneous animal matter of a neutral nature 5 per cent.

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[1] Accepted September 1972.

Only 11 per cent of the food was of vegetable nature, 6 per cent of which consisted of weed seeds and 5 per cent of miscellaneous vegetable matter. He thus concluded that 70 per cent of its food was of a beneficial nature and 30 per cent neutral.

The detailed analysis of the stomach-contents of 174 adult specimens of *Vanellus i. indicus* that I collected in the Sundarban is given in Table 18.

TABLE 18

ANALYSIS OF THE STOMACH-CONTENTS OF THE RED-WATTLED LAPWING

N = Number of specimens.
Weight = Total weight (in gramme) of examples of all species under a Class.
Length of fish = Its standard length.

Items of diet	No.	Wt.(g)	% (Wt.)	Remarks
Phylum Chordata				
Class Reptilia				
Order Squamata				
Suborder Serpentes				
Family COLUBRIDAE				
Ptyas mucosus (Linnaeus)	6			Common in cultivations. Parts of head, and body partly disgested.
Xenochrophis piscator (Schneider)	2			Common in paddy-fields.
Amphiesma stolata (Linnaeus)	4			Common on tidal mud-flats, partly digested.
Total:	12	120	1.96	
Phylum Mollusca				
Class Gastropoda				
Order Archaeogastropoda				
Family NERITIDAE				
Nerita (*Odontostomia*) *lineata* (Dillwyn)	31			Complete shells.
Order Mesogastropoda				
Family VIVIPARIDAE				
Viviparus bengalensis (Lamarck)	56			Freshwater form. Mostly complete shells.
Family PILIDAE				
Pila sp.	10			-do-
Littorina melanostoma Gray	21			-do-
Digonistoma sp.	10			-do-
Melanoides tuberculatus (Müller)	85			-do-

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Melanoides (Plotia) scabra (Müller)	17			-do-
Order Basommatophora				
Family LYMNAEIDAE				
Lymnaea acuminata (Lamarck)	40			-do-
Family PLANORBIDAE				
Indoplanorbis exustus (Deshayes)	22			Land-snail.
Shell fragments				Not identifiable.
Total:	292	1830	27.91	
Phylum Arthropoda				
Class Insecta				
Order Orthoptera				
Family LOCUSTIDAE				
Heiroglyphus banian Fabricius	81			Paddy-pest. In fragments.
Attractomorpha sp.	25			Pest of tobacco and vegetables.
Oxya sp.	31			Pest of paddy.
Chrotogonus sp.	82			Pest of cotton.
Acrotylus sp.	22			Pest of paddy nurseries.
Heteropternis sp.	19			-do-
Locusta danica Linnaeus	35			-do-
Pyrgomorpha sp.	6			-do-
Lefroya sp.	27			
Coptotettix sp.	8			
Family TETTIGIDAE				
Acrydium sp.	21			
Scelimena sp.	16			Pest of cultivated plants.
Family GRYLLIDAE				
Gryllus sp.	35			Pest of roots of paddy, etc.
Liogryllus sp.	45			-do-
Acheta bimaculata (De Geer)	30			-do-
Brachytrypes sp.	23			-do-
Family GRYLLOTALPIDAE				
Gryllotalpa africana Beanvois	91			Mostly parts of body.
Gryllotalpa sp.	27			-do-
Orthopteran fragments				Not identifiable.
Order Dermaptera				
Family LABIDURIDAE				
Labidura sp.				
Family LABIIDAE				
Labia minor (Linnaeus)	17			
Family CHELISOCHIDAE				
Chelisoches morio (Fab.)	3			

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Family FORFICULIDAE				
Forficula sp.	12			
Forficulid claspers and fragmentary remains				Not identifiable.
Order Isoptera				
Family TERMITIDAE				
Odontotermes sp. ?	26			Partially digested. Therefore identification doubtful. Pest of Sugarcane and other Gramineae.
Order Odonata				
Suborder Zygoptera				
Family COENAGRIIDAE				
Ischneura sp. ? (Naiads)	40			Aquatic form.
Coenagrion sp. ? (Naiads)	32			-do-
Suborder Anisoptera				
Family AESCHNIDAE				
Anax sp. ? (Naiads)	20			-do-
Aeschna sp. (Naiads)	27			-do-
Family LIBELLULIDAE				
Pantala sp. (Naiads)	6			-do-
Crocothemis sp. (Naiads)	9			Aquatic form.
Odonata fragments				Not identifiable.
Order Hemiptera				
Family PENTATOMIDAE				
Nezara viridula Linnaeus	25			Pest of vegetables.
Family COREIDAE				
Leptocorisa sp.	80			Pest of paddy-shoots.
Family PYRRHOCORIDAE				
Dysdercus cingulatus (Fabricius)	32			Pest of cotton, etc.
Family JASSIDAE				
Nephotettix sp.	100+			Rice leaf-hopper, pest.
Family GERRIDAE				
Halobates sp.	6			Aquatic form.
Gerris sp.	9			-do-
Family BELOSTOMATIDAE				
Belostoma sp.	7			Aquatic form, body in parts.
Family NEPIDAE				
Ranatra sp.	10			Aquatic form.
Nepa sp.	13			-do-
Family NOTONECTIDAE				
Notonecta sp. ?	21			-do-
Family CORIXIDAE				
Corixa sp.	8			
Order Lepidoptera				
Caterpillars				Partially digested. Not identifiable.

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Order Coleoptera				
Family CICINDELIDAE				
Cicindela sp.	6			
Family RUTELIDAE				
Anomala elata (Fabricius)	81			Pest of garden plants.
Family COCCINELLIDAE				
Epilachna sp.	27			Elytra only.
Family TENEBRIONIDAE				
Opatrum sp.	38			Pest of potato-tubers, etc.
Family MELOIDAE				
Mylabris pustulata Thunberg	26			Pest of earheads of paddy.
Gnathospastoides rouxi Castalenau	14			-do-
Cylindrothorax ruficollis (Fabricius)	14			-do-
Cylindrothorax ? tenuicollis	19			-do-
Epicauta sp.	28			-do-
Family CHRYSOMELIDAE				
Podagria sp.	6			Pest of *Hibiscus*.
Sagra sp. ?	3			Pest of *Dolichos lablab*.
Oides affinis Jacoby	7			Pest of paddy.
Haltica cyanea Weber	13			-do-
Dicladispa armigera (Olivier)	19			-do-
Family CURCULIONIDAE				
Episomus sp.	5			Pest of foliage of cultivated plants, especially pulses.
Myllocerus sp.	18			Pest of paddy.
Atactogaster sp.	10			Pest of cotton, vegetables, etc.
Alcides sp.	7			Pest of indigo, agathi, etc.
Pempheres affinis Fabricius	11			Pest of cotton.
Family SCARABAEIDAE				
Heliocopris bucephalus (Fabricius)	16			
Catharsius sp.	12			
Family DYTISCIDAE				
Dytiscus sp.	9			Aquatic form.
Family GYRINIDAE				
Gyrinus sp.	8			-do-
Family HYDROPHILIDAE				
Hydrocharis sp. ?	7			-do-
Berosus sp.	6			-do-
Coleoptera larvae				Mutilated beyond identification.

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Order Hymenoptera				
Family FORMICIDAE				
Dorylus orientalis Walker	108			Pest of sugarcane, but I have found it on jute also.
Solenopsis geminata Fabricius	92			Pest of brinjal.
Oecophylla smaragdina Fabricius	62			Pest of mango and other trees.
Camponotus compressus Fabricius	188			Pest of various plants.
Phidole sp.	30			
Miscellaneous insect fragment				Not identifiable.
Total:	2017	3750	63.21	
Class Arachnida				
Order Araneae				
Family ARGYOPIDAE				
Argyope sp.	100+			
Cyrtophora sp. ?	100+			In bush.
Leucage decorata (Blackwall)	100+			Common in paddy and grass.
Araneus sp.	50+			Common, in bush and paddy.
Cyclosa sp.	10+			Common in bush.
Family TETRAGNATHIDAE				
Ecuta javanica Thorell	100+			Very common in paddy and grass. Invariably found in stomachs.
Family LYCOSIDAE				
Lycosa sp.	10+			Common in ground and in grass. Invariably present in stomachs.
Hippasa sp.	20+			-do-
Family OXYOPIDAE				
Oxyopus sp. ?	30+			
Miscellaneous spider fragments				
Total:	520+	345	5.63	
Phylum Annelida				
Class Chaetopoda				
Order Oligochaeta				
Family MEGASCOLECIDAE				
Pheretima sp.	10+			In bits. Invariably present in stomachs.

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Perionyx sp.	10+			
Eutyphoeus sp. ?	5			Partially digested. Identification doubtful.
Family NAIDIDAE				
Chaetogaster sp. ?	6			Partially digested. Identification doubtful.
Family TUBIFICIDAE				
Limnodrilus sp.	10+			Tangled mass.
Miscellaneous Oligochaeta (bits)				Not identifiable.
Total:	41+	75	1.22	

The diet of this bird is solely of animal nature (Fig. 1). Of the total food consumed by 174 birds, 63.2 per cent represent insects, comprising 2017 examples belonging to 72 species. Of these 1683 examples representing 45 species are crop and vegetable pests; the rest are predators or neutral. The other items are mostly freshwater Mollusca (27.91%), spiders (5.63%), snakes (1.96%) and Oligochaeta (1.22%).

From the analysis it is seen that the Red-wattled Lapwing is a very useful bird, feeding on injurious insects that affect agriculture.

Tringa glareola Linnaeus, The Spotted Sandpiper

The Spotted Sandpiper, *Tringa glareola* Linnaeus, is a bird of the open marshes. It frequents freshwater bogs, inundated paddy-fields, flooded parts of the reclaimed area and tidal swampy forests. It moves in parties from one mul-flat to another pecking and probing for food on the exposed muddy banks during the ebb tides and at the edge of shallow water. It is a winter visitor.

Very little information is available about the food-habits of this bird. In India, Mason & Lefroy (1912, p. 268) analysed the stomach-contents of 24 examples and stated: "Of insects eaten by 24 birds, 9 are injurious, 3 beneficial and 43 neutral. Of 12 birds that contained insects, 4 took beneficial, 9 neutral and 6 injurious. Sixteen contained shells, 1 a prawn, 1 a shrimp, 3 a feather and 6 vegetable matter". Ali (1955, p. 94) stated about this and *Tringa ochropus* Linnaeus, that: "They run along on the squelchy mud picking up tit-bits or probe with their bills for food: insects, larvae, worms and molluscs". In Europe, Voous (1960, p. 97) found that the food consisted predominently of small water and marsh insects; also worms and small molluscs outside the breeding season.

The detailed analysis of the stomach-contents of 38 adult specimens that I collected in the Sundarban is given in Table 19.

DIAGRAMMATIC REPRESENTATION OF THE PERCENTAGES OF FOOD OF WATER BIRDS.

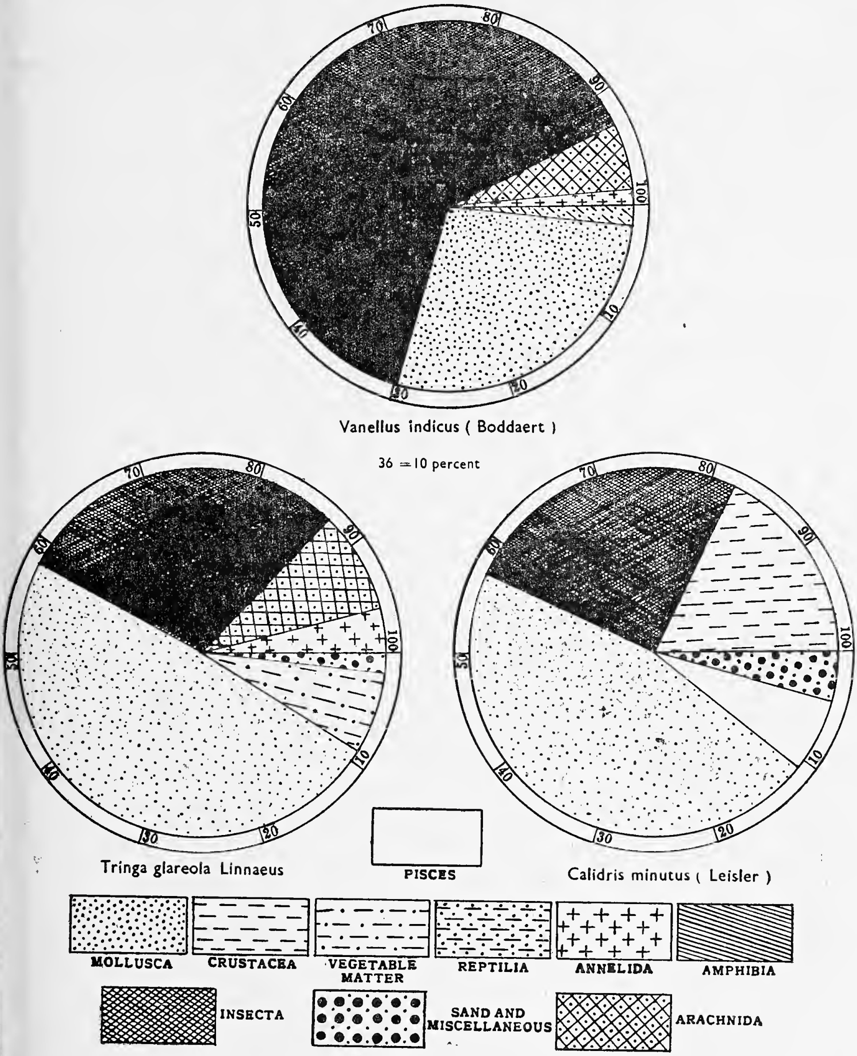


TABLE 19

ANALYSIS OF THE STOMACH-CONTENTS OF THE SPOTTED SANDPIPER

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Phylum Mollusca				
Class Gastropoda				
Order Archaeogastropoda				
Family NERITIDAE				
Nerita (*Odontostomia*) *lineata* (Dillwyn)	8			Minute shells. Brackish water form.
Order Mesogastropoda				
Family VIVIPARIDAE				
Viviparus bengalensis (Lamarck)	21			Minute shells. Freshwater form.
Family LITTORINIDAE				
Littorina melanostoma Gray	19			-do-
Family HYDROBIIDAE				
Digoinostoma pulchella (Benson)	6			-do-
Family MELANIIDAE				
Melanoides tuberculatus (Müller)	18			-do-
Melanoides scabra (Müller)	27			-do-
Order Basommatophora				
Family LYMNAEIDAE				
Lymnaea acuminata (Lamarck)	19			-do-
Family PLANORBIDAE				
Indoplanorbis exustus (Deshayes)	32			-do-
Family PATELLIDAE				
Patella sp. ?	15			Brackish water form.
Family PILIDAE				
Pila sp.	17			Freshwater form.
Family GALEODIDAE				
Melongena sp. ?	6			Brackish water form.
Class Bivalvia				
Family ARCIDAE				
Arca sp.	3			Brackish water form.
Miscellaneous molluscan fleshy pulp and shell-fragments				Not identifiable.
Total:	191	720	49.03	

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Phylum Arthropoda				
Class Insecta				
Order Orthoptera				
Family TETTIGIDAE				
Acrydium sp.	165			Pest of paddy nurseries.
Family LOCUSTIDAE				
Chrotogonus sp.	26			Pest of cotton, paddy, etc.
Order Odonata				
Suborder Anisoptera				
Naiads	25+			Mostly mutilated.
Suborder Zygoptera				
Family LIBELLULIDAE				
Naiads	40			-do-
Family COENAGRIIDAE				
Naiads	35			-do-
Order Hemiptera				
Family GERRIDAE				
Halobates sp.	60			Brackish water form.
Gerris sp. ?	78			-do-, partially digested.
Family GELASTOCORIDAE				
Limnocoris sp. ?	18+			Partially digested and mostly in fragments.
Family NEPIDAE				
Ranatra sp.	35			Freshwater form.
Nepa sp.	28			-do-
Family JASSIDAE				
Jassids	100+			Invariably present in stomachs.
Order Ephemerida				
Mayfly naiads	100+			Partially digested. Identification not possible.
Order Coleoptera				
Family GYRINIDAE				
Gyrinus sp.	16			
Family DYTISCIDAE				
Canthydrus sp.	6			Elytra and parts of body.
Laccophilus sp.	35			-do-
Bidessus sp.	40			-do-
Hydratictus sp.	3			-do-
Eretes stictus Linnaeus	100			
Order Diptera				
Family CULICIDAE				
Larvae & pupae	1000+			Patially digested.
Family CHIRONOMIDAE				
Larvae	100+			
Miscellaneous insect fragments				Not identifiable.
Total:	2010+	425	29.10	

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Class Arachnida				
Order Araneae				
Family ARGYOPIDAE				
Tetragnatha sp.	100+			Invariably present in stomachs.
Family OXYOPIDAE				
Oxyopes sp. ?	100+			
Family HERSILIDAE				
Hersila sp.	50+			
Miscellaneous spider fragments				Not identifiable.
Total:	250+	130	8.94	
Phylum Annelida				
Order Oligochaeta				
Family TUBIFICIDAE				
Limnodrilus sp.	100+			Tangled mass.
Family MAGASCOLECIDAE				
Pheretima sp.	6			
Perionix sp. ?	7			
Order Polychaeta				
Family SERPULIDAE				
Mercierella sp.	10+			Brackish water form. In bits.
Ficopomatus sp. ?	10+			-do-
Miscellaneous Annelida				Partially digested. Not identifiable.
Total:	133+	60	4.10	
Vegetable matter				
Fragments of aquatic plants and weed seeds:				Partially digested. Not identifiable.
Total:		100	6.84	
Sand		25	1.57	

The food of the Spotted Sandpiper is composed of 91.59 per cent of animal matter, 6.84 per cent of vegetable matter and 1.57 per cent of sand (Fig. 1) which is found mixed with the food. The animal matter is comprised of 49.08 per cent Mollusca in the form of minute shells and 29.10 per cent insects. Except three species of terrestrial grasshoppers, the other 20 species of insects found in the stomachs are immature aquatic forms representing naiads of dragon- and damsel-flies and, larvae and pupae of mosquitoes, chironomids, etc., and a few adult bugs and beetles. Spiders constitute 8.94 per cent of the diet, and Annelida which are represented by freshwater Oligochaeta and brackish water

Polychaeta, only 4.10 per cent. The vegetable constituents of the food is made up of fragments of aquatic plants and wild seeds to the extent of 6.84 per cent.

Since the bird destroys many harmful aquatic Diptera, such as larvae and pupae of mosquito and chironomid, it is certainly beneficial. The agriculturists are also benefitted by this bird as it devours some grass-hoppers and leafhoppers.

Calidris minutus (Leisler), The Little Stint

The Little Stint, *Calidris minutus* (Leisler), is a winter visitor to the Sundarban area from early December to the end of March. It is a social bird, often mixing with other stints and other waders, forming flocks, sometimes of considerable size. It inhabits freshwater marshes as well as the salt marshes of the estuaries, and prefers broad mud-flats of tidal rivers keeping close to the edge of the water. During the ebb tide, it searches in the silt for minute creatures and follows the water as it recedes. With the high tide it moves up to the bank and finally to the freshwater mud-flats in the interior.

Very little information is available about the food-habits of this bird. In India, Mason & Lefroy (1912, p. 270) examined the stomachs of three specimens at Pusa and found 15 neutral insects and shells. Whistler (1928, p. 364) mentions that it collects minute insects, Crustacea, worms, and the seeds of various aquatic plants. According to Baker (1929, p. 236) its food consists of insects, tiny worms, mollusca, beetles and sometimes seeds. Ali (1955, p. 96) mentions that it picks up tiny insects, crustaceans and molluscs. In Europe, Voous (1960, p. 101) found that its food consists of mainly small insects, including large quantities of mosquitoes and their larvae; and outside the breeding season large numbers of small crustaceans and snails are also taken.

The detailed analysis of the stomach-contents of 86 adult specimens that I collected in the Sundarban is given in Table 20.

TABLE 20

ANALYSIS OF THE STOMCH-CONTENTS OF THE LITTLE STINT

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Phylum Mollusca				
Class Gastropoda				
Order Mesogastropoda				
Family LITTORINIDAE				
Littorina melanostoma Gray	61			Some complete and some broken shells.

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Order Basommatophora				
Family LYMNAEIDAE				
Lymnaea acuminata (Lamarck)	32			Mostly complete shells.
Family PLANORBIDAE				
Indoplanorbis exustus (Deshayes)	19			-do-
Class Bivalva				
Family ARCIDAE				
Arca sp. ?	6			Part of opercula.
Miscellaneous shell fragments				Not identifiable.
Miscellaneous Mollusca pulp				Not identifiable.
Total:	118	425	46.18	
Phylum Arthropoda				
Class Crustacea				
Order Decapoda				
Family PALAEMONIDAE				
Macrobrachium sp.	27			Mostly in parts. Freshwater form.
Macrobrachium rude (Heller)	35			-do-
Palaemon styliferus (Milne-Edward)	29			-do-
Family PENAEIDAE				
Metapenaeus sp.	18			Brackish water form.
Family GRAPSIDAE				
Varuna litterata (Fabricius)	33+			Brackish water form, partially digested.
Miscellaneous crustacean fragments				Not identifiable.
Total:	142	172	17.70	
Class Insecta				
Order Orthoptera				
Family TETTIGIDAE				
Acrydium sp.	9			Semi-aquatic and ground-hopper.
Scelimena sp.	13			-do-
Loxilobus sp.	7			-do-
Order Dermaptera				
Family LABIIDAE				
Labia sp.	3			
Miscellaneous earwigs				Claspers and parts of body.

Items of diet	No.	Wt.(g)	% (Wt.)	Remarks
Order Ephemerida				
Family EPHEMERIDAE				
Naiads	5			Partly digested.
Order Odonata				
Suborder Zygoptera				
Family COENAGRIIDAE				
Naiads	8			-do-
Suborder Anisoptera				
Family AESCHNIDAE				
Aeschna sp. ? (naiads)	2			-do-
Miscellaneous dragon- & damselflies larvae				Not identifiable.
Order Hemiptera				
Family GERRIDAE				
Gerris sp.	17			Aquatic form. Partially digested.
Halobates sp. ?	9			
Family NAUCORIDAE				
Laccocoris sp.	6			-do-
Limnocoris sp.	4			-do-
Family NEPIDAE				
Ranatra sp.	3			Aquatic form.
Order Coleoptera				
Family DYTISCIDAE				
Laccophilus sp.				
Eretes stictus Linnaeus	17			Aquatic form.
Family GYRINIDAE				
Dineutes sp.	4			Aquatic form. Elytra and parts of body.
Gyrinus sp. ?	7+			Mostly mutilated.
Family JASSIDAE	100+			Digested beyond identification.
Order Diptera				
Family CULICIDAE				
Larvae	100+			In tangled mass. Partially digested.
Miscellaneous insect fragments				Not identifiable.
Total:	314+	230	25	
Vegetable matter:				
Panicum sp. ? (seeds)				
Grass and leaves (bits)				
Total:		55	6	
Sand Total:		40	4.35	

The food of the Little Stint consists of 89 per cent of animal matter and 6 per cent of vegetable matter, the balance (4.35%) being made up by sand (Fig. 1). The animal matter comprises of minute molluscs (46.18%) which are generally taken complete with shells; arthropods represented by freshwater and brackish water crustaceans (17.70%), and insects (25%) of mostly aquatic and a few terrestrial species. The crustaceans are of commercial value.

Since the bird consumes some crustaceans of commercial value, it does not appear to be completely a harmless bird, but its adverse effect on fishery is too little to warrant branding it as a injurious bird.

Chlidonias hybrida indica (Stephens), The Indian Whiskered Tern

The Whiskered Tern, *Chlidonias hybrida indica* (Stephens) is a common bird of the freshwater and brackish water marshes of the Sundarban area. It frequents open water bordered by dense vegetation and reedbeds. It is a winter visitor and is commonly seen in parties consisting of half a dozen to a dozen individuals, circling over drying pools and *gheries* diving from time to time to collect food.

About the food-habits of the Indian Whiskered Tern, Jerdon (1864, p. 837) stated: "This tern is exceedingly abundant in India, frequenting marshes, tanks and rivers, usually preying on aquatic food, not unfrequently hunting over fields, beds of reeds, and marshy ground, where it captures grasshoppers, caterpillars and other insects". Whistler (1928, p. 373) recorded: "Dragonflies and their larvae appear to be their staple food, but water beetles and other aquatic insects are freely taken". Baker (1929, p. 112) writes that it lives principally on water insects and larvae, dragonflies, grasshoppers, etc., and also on fish and tadpoles. Ali (1955, p. 91) states that the food comprises of tiny fishes, tadpoles, crabs, grasshoppers and other insects. The allied European subspecies *C. h. hybrida* (Pallas) takes all sorts of small animals living on or near the water's surface, such as small fish, frogs, dragonflies, and other aquatic and marsh insects (Voous, 1960, p. 131).

The detailed analysis of the stomach-contents of 13 adult specimens of the Indian subspecies that I collected in the Sundarban is given in Table 21.

TABLE 21

ANALYSIS OF THE STOMACH-CONTENTS OF THE INDIAN WHISKERED TERN

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Phylum Chordata				
Class Amphibia				
Order Anura				
Family RANIDAE				
Tadpoles	10			Partially digested beyond identification.

Items of diet	No.	Wt.(g)	% (Wt.)	Remarks
Rana limnocharis Boie	2			Subadult.
Rana tigerina Daudin ?	1			Subadult.
Miscellaneous frogs				Mutilated beyond identification.
Total:	13	20	6.66	
Series Pisces				
Class Teleostomi				
Order Cypriniformes				
Family CYPRINIDAE				
Chela sp.	7			Partly digested.
Puntius sp.	14			Length 30-40 mm. Invariably present in stomachs.
Family CLARIIDAE				
Clarius batrachus (Linnaeus)	1			Length 50 mm.
Family BAGRIDAE				
Mystus sp.	8			Length 30-40 mm. Partially digested.
Order Perciformes				
Family ANABANTIDAE				
Anabas testudineus (Bloch)	2			Length 40-50 mm.
Miscellaneous fish remains				Not identifiable.
Total:	32	50	20	
Phylum Arthropoda				
Class Crustacea				
Order Decapoda				
Family PALAEMONIDAE				
Macrobrachium sp.	19			Invariably present in stomachs.
Palaemon styliferus (Milne-Edward)	6			
Family ATYIDAE				
Caridina gracilipes de Man	10+			Fragmentary remains. Partially digested.
Miscellaneous crustacean fragments				Not identifiable.
Total:	35	50	20	

Items of diet	No.	Wt.(g)	% (Wt.)	Remarks
Class Insecta				
Order Orthoptera				
Family LOCUSTIDAE				
Hieroglyphus banian Fabricius	6			Pest of paddy.
Locusta migratoria (Reiche & Fairmaire)	4			Pest of paddy.
Attractomorpha sp.	5			Pest of paddy, vegetables, etc.
Family GRYLLIDAE				
Brachytrypes sp.	3			Pest of roots of crop, etc.
Miscellaneous orthopteran fragments				Not identifiable.
Order Odonata				
Suborder Zygoptera				
Family COENAGRIIDAE				
Naiads	25			Partially digested beyond identification.
Ceriagrion sp.	4			Wings and parts of body.
Ischneura sp.	8			-do-
Suborder Anisoptera				
Family LIBELLULIDAE				
Crocothemis sp.	16			-do-
Brachythemis sp.	13			-do-
Order Hemiptera				
Family NEPIDAE				
Nepa sp.	8			Aquatic form.
Family BELOSTOMATIDAE				
Belostoma sp.	4			Elytra and fragments of body.
Order Coleoptera				
Family DYTISCIDAE				
Laccophilus sp.	9			Aquatic form.
Family GYRINIDAE				
Gyrinus sp.				
Miscellaneous coleopteran fragments				
Order Hymenoptera				
Family VESPIDAE				
Vespa orientalis Linnaeus	7			Mutilated body.
Miscellaneous insect fragments				Not identifiable.
Total:	87	170	53.33	

The Whiskered Tern subsists solely on animal food (Fig. 2), of which 6.66 per cent consists of tadpoles and frogs; 20 per cent of small fishes (30-70 mm standard length) of commercial value; 53.33 per cent

of insects (mostly aquatic, some immature dragon- and damselflies, a few adult bugs and beetles), and some terrestrial grasshoppers which are pests of cultivated plants; the crustaceans taken are in small proportion (20%) and are of commercial value.

From the economic point of view the bird does not appear to be beneficial since 40 per cent of food consists of fishes and crustaceans of commercial value. This is far from compensated by the few insect pests of agriculture that it destroys.

Ceryle rudis leucomelanura Reichenbach, The Pied Kingfisher

The Pied Kingfisher, *Ceryle rudis leucomelanura* Reichenbach, is a common bird of the tidal rivers and creeks, inland pools and inundated fields of the Sundarban. It has not been observed in the interior of forests, and it appears to be more common in the creeks and rivers than in inland waters.

Regarding the food of the Pied Kingfisher, both Jerdon (1863, p. 234) and Blanford (1895, p. 120) state that it feeds entirely on fish. Mason & Lefroy (1912, p. 167) analysed five stomachs and concluded that the birds fed entirely on fish. Whistler (1927, p. 232) stated: "Its diet consists entirely of small fish". Baker (1927, p. 248) mentioned: "Its food is entirely aquatic and principally small fishes, though it will also eat water-insects, tadpoles, tiny prawns or very small frogs". Ali (1955, p. 56) lists fish, tadpoles, frogs and aquatic insects as its food.

The detailed analysis of the stomach-contents of 299 adult specimens that I collected in the Sundarban is given in Table 22.

TABLE 22

ANALYSIS OF THE STOMACH-CONTENTS OF THE PIED KINGFISHER

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Phylum Chordata				
Series Pisces				
Class Teleostomi				
Order Cypriniformes				
Family CYPRINIDAE				
Puntius sp.	122			Freshwater form.
Chela sp.	29			Quite common in stomachs.
Family BAGRIDAE				
Mystus sp.	187			-do-
Order Scopeliformes				
Harpodon nehereus (Hamilton)	18			Brackish water form.
Order Cyprinodontiformes				
Family CYPRINODONTIDAE				
Oryzias melastigma (McClelland)	51			

Items of diet	No.	Wt.(g)	% (Wt.)	Remarks
Order Mugiliformes				
Family MUGILIDAE				
Rhinomugil corsula (Hamilton)	17			Length 35-45 mm.
Mugil parsia (Hamilton)	117			Brackish water form.
Mugil tade Forskal	6			Quite common in stomachs.
Order Polynemiformes				
Family POLYNEMIDAE				
Polynemus paradiseus Linnaeus	12			Length 30-60 mm.
Order Perciformes				
Family AMBASSIDAE				
Ambassis sp.	126			Freshwater form. Quite common in stomachs.
Family SCIAENIDAE				
Pseudosciaena sp.	10			
Johnius sp.	18			Length 45-55 mm. Brackish water form.
Pama sp.	6			-do-
Miscellaneous fish remains				Not identifiable.
Total:	719	2246	57.0	
Phylum Arthropoda				
Class Crustacea				
Order Decapoda				
Family PALAEMONIDAE				
Macrobrachium lamerrei (Milne-Edward)	81			Freshwater form. Quite common in stomachs.
Macrobachium rude (Heller)	17			
Palaemon styliferus (Milne-Edward)	12			Freshwater form.
Family ATYIDAE				
Cardina gracilipes de Man	62			Partly digested.
Family PENAEIDAE				
Metapenaeus brevicornis (Milne-Edward)	109			Brackish water form. Quite common in stomachs.
Metapenaeus monoceros Fabricius	61			-do-
Miscellaneous crustacean fragments				Not identifiable.
Total:	342	680	17.0	

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Class Insecta				
Order Hemiptera				
Family BELOSTOMATIDAE				
Belostoma sp.	69+			Freshwater form. Quite common in stomachs.
Family NOTONECTIDAE				
Notonecta sp.	32			Some in fragments.
Family CORIXIDAE				
Corixa sp.	63			
Order Coleoptera				
Family DYTISCIDAE				
Laccophilus sp.	28			Freshwater form.
Bidessus sp.	26			
Eretes stictus Linnaeus	75			-do-. Quite common in stomachs.
Family GYRINIDAE				
Gyrinus sp.	50			Freshwater form. Quite common in stomachs.
Miscellaneous insect fragments				Not identifiable.
Total:	343	1040	26.0	

The bird consumes wholly animal food comprising of 57 per cent fishes, 26 per cent aquatic insects and 17 per cent crustaceans (Fig. 2). The fishes and crustaceans, which form the major bulk are of commercial value. Most of the fishes are brackish water forms but a few are freshwater species. These fishes measure 30-60 mm in standard length. The crustaceans on the other hand are mostly freshwater species with a few brackish water forms.

Since as much 74 per cent of its diet consists of fishes and crustaceans of commercial value, it may be regarded as a bird destructive to pisciculture.

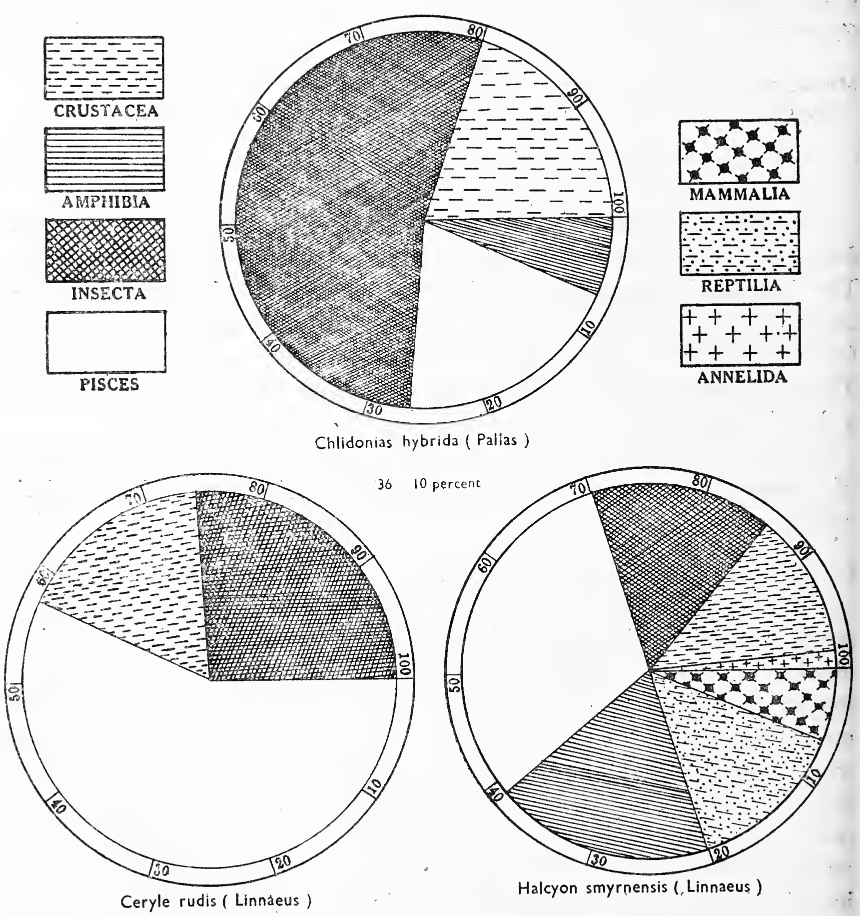
Halcyon smyrnensis fusca (Boddaert), The Whitebreasted Kingfisher

The Whitebreasted Kingfisher, *Halcyon smyrnensis fusca* (Boddaert), is mainly a bird of the plains of India. In the Sundarban area during the wet season, it is found near about freshwater ponds, jheels, waterlogged areas along the embankments and inundated or dry fields. It is rare in tidal creeks and rivers. It dives from its perch to capture its prey from either the edge of tanks or very shallow water. During dry season, however, it does not depend upon water for its food, and it disperses over a wide area perching on poles, horizontal wires across fields, trees standing in dry land and even enters thin forests in search of food. It has also been found sometimes to remain close to Cattle Egrets or graz-

ing cattle by flying from perch to perch, and insects disturbed them are picked up by it.

The food of this kingfisher is of varied nature. Jerdon (1862, p. 225) mentions that it is composed of land-crabs, mouse, lizard, grasshoppers and other insects; and near water, fish, tadpoles and water-insects. Blanford (1895, p. 132) states that though it occasionally but rarely catches fish by plunging after them, it lives chiefly on insects and small lizards and sometimes on mice and land-crabs. Mason & Lefroy (1912, p. 168) observed the bird taking grasshoppers at Pusa and Chindwara, and once eating a lizard at Pusa. Baker (1927, p. 270) wrote: "Its principal article of diet are undoubtedly grasshoppers and locusts, but it will eat almost anything not too large to swallow. Frogs, small lizards, worms, etc., are all thankfully taken and eaten; I have seen it taking cicadae from the

DIAGRAMMATIC REPRESENTATION OF THE PERCENTAGES OF FOOD OF WATER BIRDS.



trunk of trees, whilst prawns, small crabs, etc., are taken in preference to fishes when it haunts streams". Whistler (1928, p. 235) stated: "This very typical kingfisher is mainly a land-bird and feeds largely on insects, lizards, frogs and such small fry, which it captures after the manner of a Roller, flying down to them on the ground from an elevated perch. It is said very occasionally both to plunge into water after fish and to take insects on the wing". Ali (1955, p. 57) mentions fish, tadpoles, lizards, grasshoppers and other insects, young birds and mice as its food.

Gibson Hill (1951) mentions that the principal constituent of the diet of the allied form, *H. s. prepulchra* Madarasz, in Singapore is undoubtedly insects, mostly grasshoppers and other Orthoptera. Often these are taken in the larval stage. It also eats a number of lizards, chiefly skinks. He examined eight stomachs which yielded the remains of three skinks, *Mabuya* sp., feathers and head of *Munia* sp., some 15 grasshoppers and mantids, four beetles, three bees, four large black ants, a small scorpion, *Isometrus maculatus*, and two centipedes, *Scolopendra subspinipes*. There was no trace of fish or crustacea.

The detailed analysis of the stomach-contents of 192 adult specimens that I collected in the Sundarban is given in Table 23.

TABLE 23

ANALYSIS OF THE STOMACH-CONTENTS OF THE WHITEBREASTED KINGFISHER

Items of diet	No.	Wt. (g)	% (Wt.)	Remarks
Phylum Chordata				
Class Mammalia				
Order Rodentia				
Family MURIDAE				
Mus sp.	12			Partially digested.
Family SCIURIDAE				
Funambulus pennanti Wroughton	7			Mutilated, young.
Total:	19	180	6.92	
Class Reptilia				
Order Lacertilia				
Family AGAMIDAE				
Calotes sp.	31			
Order Squamata				
Suborder Serpentes				
Family COLUBRIDAE				
Ptyas mucosus (Linnaeus)	11			

Items of diet	No.	Wt.(g)	% (Wt.)	Remarks
Natrix sp.	13			
Miscellaneous Reptilia (mutilated)				Mostly small lizards. Not identifiable.
Total:	55	360	13.84	
Class Amphibia				
Order Anura				
Family RANIDAE				
Rana sp. (tadpoles)	200+			Partially digested.
Rana ? limnocharis Wiegmann	21			Some mutilated.
Rana tigerina Daudin	6			
Family BUFONIDAE				
Bufo melanostictus Schneider	9			
Miscellaneous tadpoles				Digested beyond identification.
Total:	236+	496	19.07	
Series Pisces				
Class Teleostomi				
Family CYPRINIDAE				
Puntius sp.	60			Length 10-20 mm. Freshwater form.
Family BAGRIDAE				
Mystus sp.	82			Length 10-25 mm. Partly digested.
Order Perciformes				
Family ANABANTIDAE				
Anabas testudineus (Bloch)	42			Length 20-40 mm.
Total:	184	812	31.23	
Phylum Arthropoda				
Class Crustacea				
Order Decapoda				
Family PALAEMONIDAE				
Macrobrachium sp.	71			Freshwater form.
Macrobrachium rude (Heller)	26			-do-
Palaemon styliferus Milne-Edward	18			-do-
Family POTAMONIDAE				
Paratelphusa sp.	9			Parts of body.
Miscellaneous Crustacea fragments				Not identifiable.
Total:	124	292	11.23	

Items of diet	No.	Wt.(g)	% (Wt.)	Remarks
Class Insecta				
Order Orthoptera				
Family LOCUSTIDAE				
Hieroglyphus sp.	21			Paddy pest.
Attractomorpha sp.	15			Pest of tobacco and vegetables.
Family TETTIGIDAE				
Acrydium sp.	22			
Family GRYLLIDAE				
Gryllus sp.	5			Pest of paddy-roots.
Achaeta sp.	9			-do-
Brachytrypes sp.	19			-do-
Family GRYLLOTALPIDAE				
Gryllotalpa sp.	36			-do-
Miscellaneous orthopteran fragments				Not identifiable.
Order Dermaptera				
Family LABIDURIDAE				
Labidura sp.	6			
Family CHELISOCHIDAE				
Chelisoches sp.	4			
Forficulid claspers and fragmentary remains				Not identifiable.
Order Hemiptera				
Family BELOSTOMATIDAE				
Belostoma sp.	6			Aquatic form.
Family PYRRHOCORIDAE				
Dysdercus cingulatus Fabricius	4			Pest of cotton and vegetables.
Order Lepidoptera				
Miscellaneous larvae				Partially digested beyond identification.
Order Coleoptera				
Family DYTISCIDAE				
Eretes stictus Linnaeus	12			Aquatic form.
Family DYNASTIDAE				
Oryctes rhinoceros Linnaeus	3			Pest of coconut palm.
Phyllognathus dionysius (Fabricius)	11			Pest of paddy-ears.
Family RUTILIDAE				
Anomala elata (Fabricius)	16			Underground stem-and root-feeder of cultivated plants.
Family MELOIDAE				
Epicauta sp.	27			Pest of paddy-ears.
Family CICINDELIDAE				
Cicindela sp.	9			
Miscellaneous Coleoptera (elytra)				Not identifiable.

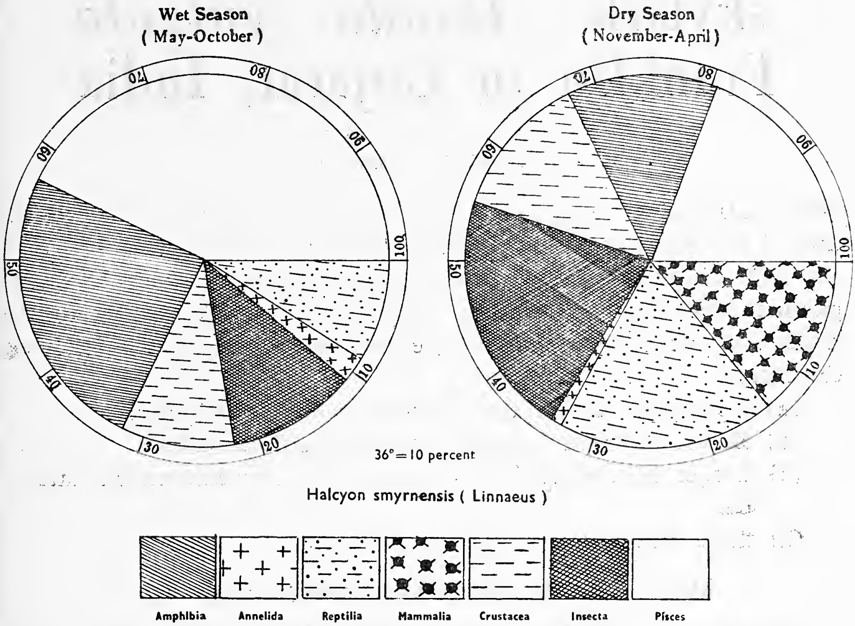
Items of diet	No.	Wt.(g)	% (Wt.)	Remarks
Order Hymenoptera				
Family FORMICIDAE				
Dorylus sp.	4			Pest of sugarcane, jute, etc.
Solenopsis sp.	6			Pest of brinjal.
Miscellaneous insect fragments				Not identifiable.
Total:	235	420	16.15	
Phylum Annelida				
Class Chaetopoda				
Order Oligochaeta				
Family MEGASCOLECIDAE				
Pheritima sp.	13+			Partially digested.
Miscellaneous earthworms (bits)				Not identifiable.
Total:	13+	40	1.53	

The entire food of the Whitebreasted Kingfisher consists of animals. It is composed of 31.23 per cent of fishes which are small fry of commercial freshwater species, 19.07 per cent of Amphibia (tadpoles, frogs and toads), 13.84 per cent of reptiles (snakes and lizards), 6.92 per cent of mammals (mouse and squirrel), 11.23 per cent of Crustacea of commercial value; 16.15 per cent of Insecta, and 1.53 per cent of Annelida represented by moist soil earthworms (Fig. 2). The insects taken by the bird have been found to be mostly pests of crops and vegetable. Out of the 235 examples representing 20 species recorded from the stomachs, 198 examples representing 14 species have been found to be injurious to crops, two predators and four neutral.

The food of this bird during the rainy (wet) season varies to some extent from that of dry season. During the wet season (May to October) when the water level is much higher and the whole area is largely inundated, the birds live more on aquatic animals, such as tadpoles, fishes, shrimps, prawns, aquatic insects and annelids; while during the drier months from November to April it consumes more of land organisms.

Out of the 192 specimens of the bird studies, 109 were collected during the wet period and 83 during the dry season. Analysis of their stomach-contents reveals the following seasonal variation (Fig. 3):

DIAGRAMMATIC REPRESENTATION OF THE PERCENTAGES OF FOOD OF WATER BIRDS



Animal groups:	Wet season: (food percentage)	Dry season: (food percentage)
Mammalia	—	14.10
Reptilia	8.84	18.74
Amphibia	25.00	13.14
Pisces	42.96	19.40
Crustacea	10.00	12.46
Insecta		
Terrestrial	3.00	16.00
Aquatic	8.14	5.16
	11.14	21.16
Annelida	2.06	1.00

From the data presented above it may be generalised that during the wet season this bird is not beneficial since it consumes fish fry and shrimps of commercial value which constitute more than half (52.96%) the total bulk of its food. On the other hand, in the dry season it does immense service to the agriculturists by consuming insect and rodent pests of agriculture, which together form 35.26 per cent of its diet.

(*to be continued*)

On a new subspecies of the skylark *Alauda gulgula* Franklin in Gujarat, India[1]

HUMAYUN ABDULALI

While cataloguing the Skylarks *Alauda gulgula* Franklin in the collection of the Bombay Natural History Society, I noticed that 7 (4♂♂ 1♀ 2o?) of the 8 specimens from Kutch and Gujarat could be distinguished from the neighbouring subspecies *punjaubi* Whistler to the north and nominate *gulgula* to the east and south by the following characters:

(a) Upperparts darker than in both *punjaubi* and *gulgula*.
(b) Breast more prominently streaked and coloured.
(c) Larger bill and hind claw, as per table of measurements attached.

On these differences, I separate them as:

Alauda gulgula dharmakumarsinhjii subsp. nov.

Holotype: ♂ collected by R. S. Dharmakumarsinhji at Bhavnagar, Gujarat, on 26 April 1953, bearing No. 21279 in the collection of the Bombay Natural History Society.

Paratypes: ♂♂ Nos. 21276, 21277 and unsexed 21278 and 21378 collected at Bhavnagar, Gujarat, by R. S. Dharmakumarsinhji on 26 April and 17 June 1953; and ♂ No. 9058 from Saiat, Kaira District, Gujarat, on 12 December 1945, and ♀ No. 9057 from Mandvi, Kutch, on 8 March 1944, both by Sálim Ali.

On the last date another skylark was obtained at the same place, which I have placed with *punjaubi*. One or the other was an immigrant or straggler.

This bird is named after R. S. Dharmakumarsinhji of Bhavnagar, the author of BIRDS OF SAURASHTRA and well known in ornithological circles in India. He sent the birds to the Bombay Natural History Society in two lots in 1953 but no correspondence other than the covering letter is now traceable and I do not know if they were ever carefully examined by anybody before.

It may also be of interest to mention that in the course of my work, I have examined some 580 sexed specimens of different species of larks, of which 65 per cent are males, the preponderance in some groups, as in the present instance, being more pronounced.

[1] Accepted December, 1974.

Alauda gulgula dharmakumarsinhjii subsp. nov.

TABLE OF MEASUREMENTS

		Wing	Bill from feathers	Tail	Hind claw
♂♂ *dharmakumarsinhjii*	(4)	91,92,93,95	12·2*,15,15·4,–	47,51,52,56	17·5-24* av. 20·2
♂♂ *punjaubi*	(9)	93-100 av. 97·3	11·8-14 av. 13	50-56 av. 54·5	12-17 av. 14·5
♂♂ *gulgula*	(13)	86-95 av. 90	13·2-14·9 av. 14·2	46-52 av. 49·6	11·3-17·3 av. 13·9
1♀ 2o? *dharmakumarsinhjii*	(3)	90,92,92	14·6,13·7,14	52,48,50	19,18·2,22·3
♀♀ *punjaubi*	(6)	87-99 av. 91·5	13-13·6 av. 13·3	47-53 av. 51	11·2-15 av. 13·6
♀♀ *gulgula*	(2)	85,88	13, 13·1	46,50	13·3, 14·1

* No. 9058 from Saiat, Kaira District has a small bill but the longest claw.

Algae of Vidarbh, Maharashtra[1]

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In this paper 636 taxa belonging to Chlorophyceae, Euglenophyceae, Xanthophyceae, Dinophyceae and Cyanophyceae are recorded from 25 different places in Vidarbh.

During the years 1964 to 1969, I collected 2538 vials of algae from Khamgaon, Mehkar and Lonar (Buldhana District), Akola, Karanja and Malegaon (Akola District), Amravati (Amravati District), Yeotmal (Yeotmal District), Pavnar, Wardha (Wardha District), Katol, Satnavri, Vena Dam, Dahegaon, Umred and Mansar (Nagpur District), Gondia, Tumsar, Tiroda, Bhandara Road, Bhandara, Jawahar Nagar and Sakoli (Bhandara District), Warora and Chandrapur (Chandrapur District). The collections were made mainly from ponds and lakes used for pisciculture. All these collections were preserved in 4% formalin. Camera lucida diagrams of all these algae have been drawn.

Vidarbh region consisting of eight districts, forms the north-eastern part of Maharashtra State. The maximum and minimum temperatures for the region are 50°C and 8°C. The rainfall varies from 70 to 125 cm for the different places of collections. The soil is mostly black and clayey.

So far *Chara brachypus* Br., *C. corallina* Willd., *C. zeylanica* Willd., *Lychnothamnus barbatus* (Meyen) Leonhardi and *Nitella hyalina* (De Cond.) Agardh from Ambazari lake, Nagpur (Kamat 1967) and *Pediastrum boryanum* (Turpin) Meneghini, *P. tetras* (Ehr.) Ralfs and *Tetraedron minimum* (A. Br.) Hansgirg from ponds in Nagpur (Philipose 1967) have been recorded from this region.

In this paper 391 taxa of Chlorophyceae, 96 taxa of Euglenophyceae, 2 taxa of Xanthophyceae, 11 taxa of Dinophyceae and 136 taxa of Cyanophyceae are included. Members of Charophyceae and Bacillariophyceae and the algae of Nagpur proper are still under study and hence not included in this paper. Many algae could not be identified for the lack of mature reproductive parts.

Rich collections were made from Vadali lake at Amravati and Ram-

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[1] Accepted April 1971.

[2] *Present address*: Botany Dept., Institute of Science, Aurangabad.

sagar lake at Tiroda while very few algae were found in Januna lake at Khamgaon and Rishi lake at Karanja. The algal flora was negligible in ponds with a dense floating vegetation particularly of species of *Azolla, Wulfia, Lemna* and *Pistia* occurring either alone or in combinations.

The pH of the water of the collection spots when studied, is given in the bracket immediately after the collection spot. The pH was found out by studying at least three samples of water from three different places of the collection spot, by using B.D.H. Universal indicator. The pH of the collection spots ranged from 7.2 in Ramsagar to 11 in a lake at Lonar.

Common algae of this region are *Coelastrum cambricum* Archer v. *intermedia* (Bohlin) G. S. West, *Ankistrodesmus falcatus* (Corda) Ralfs, *Scenedesmus bijuga* (Turpin) Lagerh. v. *alternans* (Reinsch) Hansg., *Rhizoclonium hieroglyphicum* (Ag.) Kuetz., *Pithophora oedogonia* (Mont.) Wittr., *Closterium dianae* Ehreb., *Cosmarium auriculatum* Reinsch, *Euastrum spinulosum* Delp., *Trachelomonas hispida* (Perty) Stein em. Defl., *T. volvocina* Ehrenb., *Aphanothece pallida* (Kuetz.) Rabenh., *Merismopedia glauca* (Ehrenb.) Naeg., *Spirulina major* Kuetz. ex Gomont, *Oscillatoria okeni* Ag. ex Gomont and *O. splendida* Grew ex Gomont.

Only the important works referred for the identification of these algae are given in the references.

CHLOROPHYCEAE

Chlamydomonas globosa Snow

In a puddle, Amaravati (18-10-64). In a pond (8.2), Katol (8-12-68).

C. snowii Printz

In a small pond, Akola (16-10-68).

Gonium pectorale Muell.

In a pool, Khamgaon (13-10-67). In Mendhe lake (9.5), Bhandara (19-10-68). In Abkari lake (7.5), Bhandara (9-12-68).

Pandorina morum (Muell.) Bory

In ponds, Umred (30-11-64), Mansar (13-12-64). In pools, Amravati (18-10-68). In Mendhe lake (9.5), Bhandara (19-1-69). In Ramsagar lake (7.2), Tiroda (2-2-69).

Eudorina elegans Ehrenberg

In Abkari lake (7.5), Bhadara (28-12-68).

Sphaerocystis schroeteri Chodat

In Abkari lake (7.5), Bhandara (29-11-68). In Sarkari lake (7.2), Tumsar (22-12-68). In Ramsagar lake (7.2), Tiroda (2-2-69).

Gloeocystis ampla (Kuetz.) Lagerh.

In a pond, Umred (30-11-64).

G. gigas (Kuetz.) Lagerh.

In Vadali lake, Amravati (18-10-64).

Tetraspora gelatinosa (Vauch.) Desvaux

In a lake (8), Yeotmal (14-11-68).

T. lacustris Lemm.

In Abkari lake (7.5), Bhandara (28-11-68).

Elakatothrix viridis (Snow) Printz

In paddy fields, Amravati (13-10-64). In newly constricted cement cisterns, Khamgaon (13-10-67), Akola (13-10-68), Bhandara (12-1-69).

Micractinium pusillum Fresen

In Khamb lake (9), Bhandara (28-12-68).

Dictyosphaerium pulchellum Wood
In Nursery pond (8), Bhandara (21-12-68).

Dimorphococcus lunatus A. Br.
In a pond, Umred (30-11-64). In Abkari lake (7.5), Bhandara (28-12-68). In Mendhe lake (9.5), Bhandara (19-1-69).

Schroederia indica Philipose
Planktonic in a bodhan, Amravati (18-10-64).

S. robusta Korsh.
Planktonic in a pool, Wardha (14-10-65).

S. setigera (Schroeder) Lemm.
Planktonic in a bodhan[1], Amravati (18-10-64). Pyrenoids present.

Korshikoviella gracilipes (Lamb.) Silva
Planktonic in a pool, Amravati (18-10-64).

Pediastrum boryanum (Turpin) Meneghini
In a lake (8.2), Dahegaon (27-12-64). In Vadali lake, Amravati (3-3-65). In Ramsagar lake (7.2), Tiroda (2-2-69).

P. duplex Meyen
In a pond, Mansar (13-12-64). In a lake (8), Yeotmal (24-11-68). In Nave lake (9.5), Bhandara (19-1-69).

P. duplex Meyen v. **clathratum** (A. Br.) Lagerh.
In Abkari lake (7.5), Bhandara (28-12-68).

P. duplex Meyen v. **cohaerens** Bohlin
In a pond, Mansar (13-12-64). In Sarkari lake (7.2), Tumsar (22-12-68). In Nave lake (9.5), Bhandara (19-1-69). In Ramsagar lake (7.2), Tiroda (2-2-69).

P. duplex Meyen v. **gracilimum** West et West
In a pond (8.5), Bhandara Road (19-1-69).

P. integrum Naeg. v. **perforatum** Racib.
In Ramsagar lake (7.2), Tiroda (2-2-69). Cells broader up to 35 μ.

P. muticum Kuetz.
In ponds, Mansar (13-12-64).

[1] Bodhan = Buffalo wallow.

P. simplex Meyen
In Vadali lake, Amravati (18-10-64). In droppings of birds near Vena dam (1-2-69). In a pond, Bhandara (3-3-69).

P. simplex Meyen v. **duodenarium** (Baily) Rabenh.
In Vadali lake, Amravati (3-3-65). In a pond (8.5), Bhandara Road (19-1-69).

P. tetras (Ehrenb.) Ralfs
In ponds, Umred (30-11-64), Mansar (13-12-64). In Vadali lake, Amravati (3-3-65). In Sarkari lake (7.2), Tumsar (22-12-68). In Mendhe lake (9.5), Bhandara (19-1-69).

P. tetras (Ehrenb.) Ralfs. v. **tetraedron** (Corda) Hansg.
In Pavnar dam (27-10-64).

Sorastrum americanum (Bohlin) Schmidle
In a pond, Mansar (13-12-64). In Sarkari lake (7.2), Tumsar (22-12-68). In Abkari lake (7.5), Bhandara (29-12-68).

S. americanum (Bohlin) Schmidle v. **undulatum** G. M. Smith
In Vadali lake, Amravati (3-3-65).

S. spinulosum Naeg.
In paddy fields, Amravati (18-10-64). In Sarkari lake (7.2), Tumsar (22-12-68). In Abkari lake (7.5), Bhandara (19-12-68).

Coelastrum cambricum Arch. v. **intermedium** (Bohlin) G. S. West
In Vadali lake, Amravati (18-10-64; 3-3-65). In ponds, Umred (30-11-64). In Sarkari lake (7.2), Tumsar (22-12-64). In Abkari lake (7.5), Bhandara (29-12-68). In Mendhe lake (9.5), Bhandara (19-1-69). In Ramsagar lake (7.2), Tiroda (2-2-69).

C. microporum Naeg.
In Sarkari lake (7.2), Tumsar (29-12-68). In Ramsagar lake (7.2), Tiroda (2-2-69).

C. reticulatum (Dang.) Senn
In Abkari lake (7.5) Bhandara (29-12-68).

Westella botryoides (W. West) De Wild.
In a nursery pond (8), Bhandara (28-12-68).

Nephrocytium hydrophilum (Turn.) Wille
In Vadali lake, Amravati (3-3-65).

N. obesum West et West
In paddy fields, Amravati (13-12-64).

Trochiscia reticularis (Reinsch) Hansg.
In ponds, Mansar (13-12-64).

Oocystis borgei Snow
In Pavnar dam (27-10-64). In Zarpat stream, Chanda (1-11-64). In Sarkari lake (7.2), Tumsar (22-12-68). In Nursery pond (8), Bhandara (28-12-68). In Ramsagar lake (7.2), Tiroda (2-2-69).

O. elliptica W. West
In ponds, Umred (30-11-64). In Vadali lake, Amravati (3-3-65).

O. gigas Arch.
In Vadali lake, Amravati (18-10-64).

O. macrospora (Turn.) Brunnth.
Rare. In a pond, Mansar (13-12-64).

O. pusilla Hansg.
In Sarkari lake (7.2), Tumsar (22-12-68). In Abkari lake (7.5), Bhandara (29-12-68).

O. solitaria Wittr. v. **major** Wille
In a pond, Mansar (13-12-64).

Gloeotaenium loitsbergianum Hansg.
In Vadali lake, Amravati (18-10-64; 3-3-65). In Abkari lake (7.5), Bhandara (19-1-69).

Ankistrodesmus convolutus Corda
In Mendhe lake (9.5), Bhandara (19-1-69).

A. falcatus (Corda) Ralfs
In ponds, Umred (30-11-64), Mansar (13-12-64). In Vadali lake, Amravati (3-3-65). In Sarkari lake (7.2), Tumsar (22-12-68). In Ramsagar lake (7.2), Tiroda (2-2-69).

A. falcatus (Corda) Ralfs v. **acicularis** (A. Br.) G. S. West
In a cement cistern, Amravati (18-10-64). In Nursery pond (8), Bhandara (28-12-68).

A. falcatus (Corda) Ralfs v. **mirabilis** (West et West) G. S. West
In Vadali lake, Amravati (3-3-65).

A. falcatus (Corda) Ralfs v. **tumidus** (West et West) G. S. West
In paddy fields and in cement cisterns, Amravati (18-10-64).

A. spiralis (Turn.) Lemm.
In ponds, Umred (30-11-64). In Abkari lake (7.5), Bhandara (26-12-68).

Selenastrum bibraianum Reinsch
In a pond, Umred (30-11-64).

Kirchneriella lunaris (Kirchn.) Moebius
In Mendhe lake (9.5), Bhandara (19-1-69).

K. lunaris (Kirchn.) Moebius v. **irregularis** G. M. Smith
In ponds, Umred (30-11-64).

K. subsolitaria G. S. West
In Mendhe lake (9.5), Bhandara (19-1-69).
Cells sometimes bigger in size, up to 6.5 μ broad and 20 μ long.

Tetraedron hastatum (Reinsch) Hansg.
Very rare. In a bodhan, Amravati (13-10-64).

T. minimum (A. Br.) Hansg.
In Vadali lake, Amravati (3-3-65).

T. pentaedricum West et West
In Khamb lake (9), Bhandara (28-12-68).

T. pusillum (Wall.) West et West
In Nursery pond (8), Bhandara (12-1-69).

T. trigonum (Naeg.) Hansg.
In Vadali lake, Amravati (3-3-65). In Nursery pond (8), Bhandara (28-12-68).

Scenedesmus arcuatus Lemm. v. **platydisca** G. M. Smith
In a pool, Satnavari (18-10-64). In ponds, Umred (30-11-64). In Mendhe pond (9.5), Bhandara (19-1-69).

S. bijuga (Turp.) Lagerh.
In a pond (8.5), Bhandara Road (19-1-69).

S. bijuga (Turp.) Lagerh. v. **alternans** (Reinsch) Hansg.
In ponds, Umred (30-11-64), Mansar (13-12-64). In Zarpat stream, Chanda (1-11-65). In Sarkari lake (7.2), Tumsar (22-12-68). In Abkari lake (7.5), Bhandara (28-12-68).

S. bijuga (Turp.) Lagerh. v. **alternans** (Reinsch) Hansg. f. **parvus** G. M. Smith

In pools, Wardha (14-10-64). In Zarpat stream, Chanda (1-11-65).

S. denticulatus Lagerh.

In Abkari lake (7.2), Bhandara (29-12-68).

S. denticulatus Lagerh. v. **australis** Playf.

In Abkari lake (7.2), Bhandara (29-12-68).

S. dimorphus (Turp.) Kuetz.

In Zarpat stream, Chanda (1-11-64). In Vadali lake, Amravati (3-3-65). In Sarkari lake (7.2), Tumsar (22-12-68). In a pond (8.5), Bhandara Road (19-1-69).

S. hystrix Lagerh.

In Abkari lake (7.2), Bhandara (28-12-68).

S. longus Meyen

In ponds, Umred (30-11-64).

S. longus Meyen v. **minutum** G. M. Smith

In Abkari lake (7.2), Bhandara (29-12-68).

S. obliquus (Turp.) Kuetz.

In Sarkari lake (7.2), Tumsar (22-12-68). In Nursery pond (8), Bhandara (22-12-68).

S. quadricauda (Turp.) De Breb. v. **longispina** (Chodat) G. M. Smith

In a pool, Satnavri (18-10-64). In Zarpat stream, Chanda (1-11-64).

S. quadricauda (Turp.) De Breb. v. **maximus** West et West

In a gutter, Wardha (27-10-64). In Sarkari lake (7.2), Tumsar (22-12-68). In a pond (8.5), Bhandara Road (19-1-69).

Crucigenia rectangularis (Naeg.) Gay

Rare. In Vadali lake, Amravati (18-10-64).

Tetrallantos lagerheimii Teiling

In a pond, Umred (30-11-64).

Ulothrix aequalis Kuetz.

In a pond, Umred (30-11-64).

U. cylindricum Prescott

In a pool, Wardha (27-10-64).

U. subconstricta G. S. West

In a pond, Umred (30-11-64).

U. tenerrima (Kuetz.) Kuetz.

In a drying bodhan, Satnavri (18-10-64). In a pond, Umred (20-11-64). In Vadali lake, Amravati (3-3-65). In a pond (8.2), Tumsar (22-11-68).

Cylindrocapsa oedogoniodes Randhawa

In a pond, Mansar (13-12-67).

Stigeoclonium attenuatum (Hazen) Collins

In a pond, Umred (30-11-64).

S. hubneri Heering

In Sarkari lake (7.2), Tumsar (22-12-68).

The alga is characterized by long, multicellular hairs.

S. lubricum (Dillw.) Kuetz.

Adhering to the stones in a streamlet, Amravati (18-10-64).

S. nanum Kuetz.

In ponds, Umred (30-11-64), Mansar (13-12-64).

Chaetophora pisciformis (Roth) Agardh

Common. In puddles, pools, Mansar (20-9-64).

Coleochaete irregularis Pringsheim

Epiphytic on *Chara* sp. in Sarkari lake (7.2), Tumsar (22-11-68).

C. orbicularis Pringsheim

Epiphytic on aquatic plants in ponds, Mansar (13-12-64). In Vadali lake (9), Amravati (18-10-69). In Sarkari lake (7.2), Tumsar (22-12-68).

C. scutata De Breb.

Epiphytic on *Ipomoea* sp. in Sarkari lake (7.2), Tumsar (22-12-68). Epiphytic on grass in Ramsagar (7.2), Tiroda (2-2-69).

C. soluta (De Breb.) Pringsheim

Epiphytic on grass in Ramsagar lake (7.2), Tiroda (2-2-69).

Protococcus viridis C. A. Agardh

On moist earthen pots, Amravati (18-10-64).

Fritschiella tuberosus Iyengar

On moist soil near Gaon lake, Sakoli (5-10-69).

Chaetosphaeridium globosum (Nordst.) Klebahn

In Ramsagar lake (7.2), Tiroda (2-2-69).

C. pringsheimii Klebahn f. **conferta** Klebahn

In Abkari lake (7.5), Tumsar (29-11-68).

Gomontia holdenii Collins

In mucilaginous masses of other algae, in a pond, Umred (30-11-64).

Rhizoclonium hieroglyphicum (C. A. Ag.) Kuetz.

Common. In a streamlet, Amravati (18-10-64). In Pavnar dam (27-10-64). On dripping rocks, Amravati (3-3-65). In cement cisterns, Khamgaon (13-10-67), Bhandara (12-1-69), Amravati (2-3-69), Wardha (4-4-69). On dripping stone and brick walls near Gaumukh, Lonar (24-10-68), Khamb lake (9), Tiroda (2-2-69). On shaded moist soil, Akola (6-3-69).

The alga shows variation in size. Usually there is no branching and when it is present, the branches are very short and one to two-celled.

Pithophora oedogonia (Mont.) Wittr.

Common. In small pools, puddles, cement cisterns and at the shore of ponds, Amravati, Dahegaon, Katol, Khamgaon, Gondia, Sakoli, Wardha, Tiroda (August-March).

Cladophora glomerata (L.) Kuetz.

Attached to the sides of cement cisterns, Amravati (18-10-64). Epizoic on snails in ponds, lakes, Amravati, Gondia, Lonar, Sakoli and Yeotmal (October-March).

Oedogonium aster Wittr. ex Hirn

In Vadali lake, Amravati (3-3-65).

O. australianum Hirn

In a pond, Mansar (13-12-64).

O. autumnale Wittr. ex Hirn

In ponds, Umred (30-11-64).

O. calvum Wittr. ex Hirn

In Ramsagar lake (7.2), Tiroda (2-2-69).

O. cardiacum (Hass.) Wittr. ex Hirn f. **interjectum** Hirn

In Abkari lake (7.5), Bhandara (29-11-68).

O. crispum (Hass.) Wittr. ex Hirn

In a pond, Umred (30-11-64).

O. elegans West et West v. **americanum** Jao

In a pond, Ramtek (13-12-64). In Ramsagar lake (7.2), Tiroda (2-2-69).

The alga from Ramsagar lake has longer vegetative cells—up to 80 μ long.

O. ellipsoideum Jao

In a pond, Mansar (13-12-64). Oogonia slightly longer—up to 81 μ long.

O. flexuosum Hirn

In a lake (8), Yeotmal (24-11-68).

Hirn (1900), Tiffany (1930) and Gemeinhardt (1939) describe the alga as incompletely known. In Yeotmal material male filaments are also present. Vegetative cells 19-22 μ broad, 21-23 (-24.5) μ long; antheridia in series of 4-12, 16.2-17.4 μ broad, 6.5-12.2 μ long.

The alga is heavily calcium incrustated.

O. inconspicuum Hirn

In a pond, Mansar (13-12-64).

O. inframediale Jao

In a pond, Mansar (13-12-64).

O. obesum (Wittr.) Hirn

In Nave lake (9.5), Bhandara (12-1-69).

O. obtruncatum Wittr. ex Hirn v. **ellipsoideum** Wittr. ex Hirn

In Abkari lake (7.5), Bhandara (29-11-68).

O. plagiostomum Wittr. ex Hirn v. **gracilis** Wittr. ex Hirn

In Khamb lake (9), Bhandara (28-12-68).

O. poecilosporum Nord. et Hirn

In Ramsagar lake (7.2), Tiroda (2-2-69).

O. porrectum Nordst. ex Hirn

In a pond, Mansar (13-12-64).

O. pringsheimii Cramer: Wittr. ex Hirn v. **nordstedtii** Wittr. ex Hirn

In Nave lake (9.5), Bhandara (19-1-69).

Male filaments not observed. Female filament cells slightly capitellate.

O. pseudospirale Nygaard

In Nave lake (9.5), Bhandara (19-1-69).

O. pusillum Kirchn. ex Hirn

In paddy fields, Vadali lake, Amravati (18-10-64). In Sarkari lake

(7.2), Tumsar (22-12-68).

O. santurcense Tiff.

In a pond, Umred (30-11-64). In Abkari lake (7.2), Bhandara (28-11-68).

O. subaerolatum Jao

In paddy fields, Amravati (18-10-64).

O. tapeinosporum Wittr. ex Hirn

In Vadali lake, Amravati (3-3-65). In Ramsagar lake (7.2), Tiroda (2-2-69).

O. undulatum (Breb.) Al. Braun; Wittr. ex Hirn

In Vadali lake, Amravati (18-10-64, 3-3-65). In a pond, Umred (30-11-64). In Nave lake (9.5), Bhandara (19-1-69). In Ramsagar lake (7.2), Tiroda (2-2-69). In a pond, Wardha (15-10-69).

O. urbicum Wittr. ex Hirn

In Nave lake (9.5), Bhandara (19-1-69).

O. virceburgense Hirn

In paddy fields, Vadali lake, Amravati (18-10-64). In Ramsagar lake (7.2), Tiroda (2-2-69).

Bulbochaete diamesandria Nordstedt ex Hirn

In ponds, Umred (30-11-64), Mansar (13-12-64). In Ramsagar lake (7.2), Tiroda (2-2-69).

B. lagoensis Wittr. ex Hirn

In Ramsagar lake (7.2), Tiroda (2-2-69).

B. varians Wittr. ex Hirn

Very rare. In Vadali lake, Amravati (3-3-65).

Netrium digitus (Ehrenb.) Itzig. et Roth v. **lamellosum** (Breb.) Gronbl.

In Ramsagar lake (7.2), Tiroda (2-2-69).

Cylindrocystis americana West et West v. **minor** Cushm.

In a pond (7.8), Mansar (9-10-69).

Gonatozygon aculeatum Hast.

In a pond (8), Mansar (9-10-69).

G. kinahani (Arch.) Rabenh.

In a pond, Mansar (13-12-64).

G. monotaenium De Bary

In ponds, Umred (30-11-64). In Sarkari lake (7.2), Tumsar (22-12-68). In Gaon pond (8), Sakoli (7-1-69). In Nave lake (9.5), Bhandara (19-1-69). In Ramsagar lake (7.2), Tiroda (2-2-69).

G. pilosum Wille

In a pond, Mansar (13-12-64).

Pleurotaenium baculoides (Roy et Biss.) Playf.

In a streamlet, Satnavri (18-10-64). In a pond, Mansar (13-12-64). In Ramsagar lake (7.2), Tiroda (2-2-69).

Zygospores are present in Tiroda material. They are ellipsoid, 56-62 μ broad, 80-84 μ long, with spiny outer wall.

P. ehrenbergii (Breb.) De Bary

In Sarkari lake (7.2), Tumsar (22-12-68).

P. elatum (Turner) Borge v. **subundulatum** Hirano

In a rock pool, Satnavri (18-10-64).

P. indicum (Grun.) Lund

In Abkari lake (7.5), Bhandara (29-11-68). In Sarkari lake (7.2), Tumsar (22-12-68).

P. inermium (Moeb.) Hirano

In a pond, Umred (30-11-64). In Ramala lake, Chandrapur (1-11-65). In Nave lake (9.5), Bhandara (19-1-69).

P. ovatum Nordst.

In a streamlet, Satnavri (18-10-64). In a pond, Mansar (13-12-64). In Ramala lake, Chandrapur (1-11-65). In Nave lake (9.5), Bhandara (19-1-69).

P. simplicissimum Gronbl.

In Sarkari lake (7.2), Tumsar (22-12-68).

P. simplicissimum Gronbl. v. **semiundulatum** Hirano

In a pond, Umred (20-10-64). In Ramala lake, Chandrapur (1-11-65). In Sarkari lake (7.2), Tumsar (22-12-68).

P. subcoronulatum (Turn.) West et West

In a pond, Mansar (13-12-64).

P. trabecula (Ehrenb.) Naeg.

In Vadali lake, Amravati (18-10-64). In Motha lake, Umred (30-11-

64). In Sarkari lake (7.2), Tumsar (22-12-68).

Curved semicells are commonly found in Tumsar material.

P. trabecula (Ehrenb.) Naeg. f. **clavata** (Kuetz.) West et West

In a pond, Mansar (13-12-64).

Occasionally cells longer—up to 615 μ long.

P. trabecula (Ehrenb.) Naeg. v. **maximum** (Reinsch) Roll f. **constrictum** Scott et Prescott

In Nave lake (9.5), Bhandara (19-1-69).

P. trabecula (Ehrenb.) Naeg. v. **rectum** (Delp.) West et West

In a pond, Umred (30-11-64). In Vadali lake, Amravati (3-3-65). In Ramsagar lake (7.2), and Belati pond (7.5), Tiroda (2-2-69).

Closterium acerosum (Schrank) Ehrenberg

In a pond, Umred (30-11-64).

C. acerosum (Schrank) Ehrenb. f. **rectum** Scott et Prescott

In Zarpat stream, Chandrapur (1-11-65).

C. aciculare West et West

In Vadali lake, Amravati (3-3-65).

C. acutum Breb.

In ponds, Umred (30-11-64), Mansar (13-12-64), and in Nursery pond (8), Bhandara (28-12-68).

C. acutum Breb. v. **variable** (Lemm.) Krieger

In a rock pool, Satnavri (18-12-64). In Nave lake (8), Sakoli (5-1-69).

C. calosporum Wittr.

In a puddle, Wardha (3-4-65).

C. calosporum Wittr. v. **brasiliense** Borg.

In a pond, Umred (30-11-64).

C. cornu Ehrenb.

In a streamlet, Satnavri (18-10-64). In a lake (8), Yeotmal (24-11-68). In Sarkari lake (7.2), Tumsar (22-12-68).

The Yeotmal alga agrees with form *alfa* of Croasdale (1955).

C. cornu Ehrenb. v. **upsaliense** Nordst.

In a pond, Umred (30-11-64).

C. cynthia De Not

In a pond, Umred (13-11-64). In Ramsagar lake (7.2), Tiroda (2-2-69).

Striations 6-8 in 10 μ.

C. dianae Ehrenb.

In a pond, Umred (30-11-64). In a lake (8.2), Dahegaon (27-12-64). In Vadali lake, Amravati (3-3-65). In Abkari lake (7.2), Bhandara (29-12-68). In a pond (8.2), Jawahar Nagar (12-1-69). In Mendhe lake (9.5), Bhandara (19-1-69).

C. ehrenbergii Menegh.

In a pond, Umred (30-11-64).

C. gracile Breb.

In bodhans, Amravati (18-10-64). In Zarpat stream, Chandrapur (1-11-65).

C. idiosporum West et West

In a lake (8), Yeotmal (24-11-68).

C. incurvum Breb.

In a streamlet, Satnavri (18-10-64). In Vadali lake, Amravati (18-10-64, 3-3-65). In a lake (7.2), Sakoli (14-1-68). In Sarkari lake (7.2), Tumsar (22-12-68). In Ramsagar lake (7.2), Tiroda (2-2-69).

C. jenneri Ralfs

In a streamlet, Satnavri (18-10-64). In a pond (8.2), Dahegaon (27-12-67). In Mendhe lake (9.5), Bhandara (19-1-69).

C. jenneri Ralfs v. **tenue** Croasdale

In a pond, Umred (30-11-64). In Mendhe lake (9.5), Bhandara (19-1-69).

C. kuetzingii Breb.

In a pond, Umred (30-11-64).

C. lanceolatum Kuetz.

In a pool, Satnavri (18-10-64). In bodhans, Amravati (18-10-64). In ponds, Umred (30-11-64).

C. leibleinii Kuetz.

In puddles, Mansar (13-12-64).

C. libellula Focke

In Ramsagar lake (7.2), Tiroda (2-2-69).

C. lineatum Ehrenb.

In a pond, Mansar (13-12-64).

C. littorale Gay

In ponds, Umred (30-11-64). In Sarkari lake (7.2), Tumsar (22-12-68). In Abkari lake (7.5), Bhandara

(28-12-68). In Ramsagar lake (7.2), Tiroda (2-2-69).

C. macilentum Breb.

In Sarkari lake (7.2), Tumsar (22-12-68). In Gaon lake (7.2), Sakoli (5-1-69).

C. parvulum Naeg.

In a streamlet, Satnavri (18-10-64). In a pond, Umred (30-11-64). In Ramala lake, Chandrapur (1-11-65). In Sarkari lake (7.2), Tumsar (22-12-68).

C. setaceum Ehrenb.

In a pond, Umred (30-11-64).

C. sinense Lutkem.

In a streamlet, Satnavri (18-10-64). In Sarkari lake (7.2), Tumsar (22-12-68).

C. tumidulum Gay

In Vadali lake, Amravati (3-3-65, 18-10-69). In a lake (8), Yeotmal (24-11-68). In Sarkari lake (7.2), Tumsar (22-12-68). In Abkari lake (7.5), Bhandara (29-12-68).

C. tumidum Johnson

In a pond, Mansar (13-12-64).

C. venus Kuetz.

In a pond, Mansar (13-12-64). In a pond (8), Jawahar Nagar (12-1-69).

C. venus Kuetz. v. **incurvum** (Breb.) Krieger

In Vadali lake, Amravati (3-3-65).

Cosmarium abbreviatum Racib.

In Nave lake (9.5), Bhandara (19-1-69).

C. abbreviatum Racib. f. **pygmaea** Messik.

In Vadali lake, Amravati (18-10-64, 3-3-65).

C. amoenum Breb.

In a pond, Umred (30-11-64). In Abkari lake (7.5), Bhandara (29-11-68).

C. angulosum Breb. v. **concinuum** (Rabenh.) West et West

In a pond (8), Jawahar Nagar (12-1-69).

C. auriculatum Reinsch

In a pool, Satnavri (18-10-64). In Vadali lake, Amravati (18-10-64). In Zarpat stream, Chandrapur (1-11-65). In ponds, Mansar (10-12-65). In Sarkari lake (7.2), Tumsar (22-12-68). In Abkari lake (7.5), Bhandara (29-12-68).

Cells slightly shorter up to 48 μ long and cell wall finely punctate.

C. bengalense (Grun.) Turn.

In a pond, Umred (30-11-64). In Sarkari lake (7.2), Tumsar (22-12-68). In Abkari lake (7.5), Bhandara (28-12-68).

Bhandara alga is slightly bigger—up to 49 μ broad, 82 μ long.

C. biloculatum Breb. v. **subpunctulatum** Krieger et Gerloff

In a pond, Umred (30-11-64). In Nave lake (9.5), Bhandara (19-1-69).

C. binum Nordst.

In a pond, Umred (30-11-64).

C. botrytis Menegh.

Rare. In Vadali lake, Amravati (3-3-65).

C. ceylanicum West et West f. **minus** Scott et Prescott

In a pond, Mansar (13-12-64).

C. connatum Breb.

In paddy fields, Amravati (18-10-64).

C. contractum Kirchn.

In a pond, Umred (30-11-64).

C. contractum Kirchn. f. **jacobsenii** (Roy) West et West

In paddy fields, Amravati (18-10-64). In ponds, Mansar (13-12-64). In Sarkari lake (7.2), Tumsar (22-12-68).

C. contractum Kirchn. v. **ellipsoideum** (Elfv.) West et West

In Vadali lake, Amravati (18-10-64). In a pond, Mansar (13-12-64).

C. contractum Kirchn. v. **minutum** (Delp.) West et West

In a pond, Mansar (13-12-64).

C. contractum Kirchn. v. **norvegicum** Racib.

In a pond (8), Jawahar Nagar (12-1-69).

C. cucurbitinum (Biss.) Lutkem.

In a pond, Mansar (13-12-64). In Ramsagar lake (7.2), Tiroda (2-2-69).

C. cucurbitinum (Biss.) Lutkem. v. **grande** Gronbl.

In paddy fields, Amravati (18-10-64).

C. depressum (Naeg.) Lund v. **intermedium** (Gutw.) Messik.

In the scum on submerged stones in Kapsi lake (8.2), Akola (18-10-68).

The cells much smaller, 21-25 μ broad, 22-27 μ long, isthmus 6-7 μ broad.

C. difficile Lutkem. v. **dialatum** Borge

In ponds, Mansar (13-12-64).

C. dispersum Johnson

In Abkari lake (7.5), Bhandara (29-12-68).

Cells slightly broader.

C. dispersum Johnson v. **truncatum** (West et West) Krieger et Gerloff

In Abkari lake (7.5), Bhandara (22-11-68).

C. dubicum Borge

In Vadali lake, Amravati (18-10-64). In Ramsagar lake (7.2), Tiroda (2-2-69).

C. dybowskii Gutw.

In Mendhe lake (9.5), Bhandara (19-1-69).

C. elegantissimum Lund f. **minor** West

In ponds, Mansar (13-12-64).

C. exiguum Arch.

In a pond, Umred (30-11-64).

C. freemanii West et West

In a pond, Umred (30-11-64).

C. furcatospermum West et West v. **koreana** Skv.

In cement cisterns, Amravati (18-10-64).

C. fusceense Hirano

In a pond, Mansar (13-12-64). In scum on the submerged stones in Kapsi lake (8.2), Akola (16-10-68).

Present alga is bigger than the type — 13-15 μ broad, 10-20 μ long.

C. garrolense Roy et Biss. v. **crassum** Jao

In paddy fields, Amravati (18-10-64).

C. granatum Breb.

In Vadali lake, Amravati (18-10-64).

C. hammeri Reinsch v. **homalodermum** (Nordst.) West et West

In Mendhe lake (9.5), Bhandara (19-1-69).

C. hammeri Reinsch v. **protuberans** West et West

In Vadali lake, Amravati (18-10-64).

C. impressulum Elfv.

In Vadali lake, Amravati (18-10-64). In Zarpat stream, Chandrapur (1-11-65). In Sarkari lake (7.2), Tumsar (22-12-68).

C. impressulum Elfv. v. **octangularis** Hirano

In Ramsagar lake (7.2), Tiroda (2-2-69).

C. inconspicuum Arch.

In Vadali lake, Amravati (18-10-64).

C. infirmum Gronbl. v. **minus** (Gronbl.) Krieger et Gerloff

In a pond (8), Jawahar Nagar (12-1-69).

C. laeve Rabenh.

In Vadali lake, Amravati (18-10-64). Adhering to the rocks near Gandhi ghat, Pavnar (27-10-64). In a pond, Umred (30-11-64).

C. laeve Rabenh. v. **depressum** Croasdale

In Vadali lake and nearby paddy fields, Amravati (18-10-64). In Sarkari lake (7.2), Tumsar (22-12-68).

The alga is sometimes slightly bigger, 10.5-10.8 μ broad, 14.5-15 μ long. It agrees well with the figures given by Croasdale (1956) but not with the figures given by Krieger and Gerloff (1969), pl. 44, f. 7a) though the figures are reproduced from Croasdale, the sinus being shown differently.

C. lagenarioides (Roy) Lutk.

In Mendhe lake (9.5), Bhandara (19-1-69).

C. lunatum Wolle v. **sparsum** (Turn.) Krieger et Gerloff

In a pond, Mansar (13-12-64).

The present alga is bigger in size, 40-42 μ broad, 28-29 μ long, isthmus 10-10.5 μ broad.

C. lundellii Delp. v. **circulare** (Reinsch) Krieger

In Vadali lake, Amravati (3-3-65). In the scum on the submerged stones

in Kapsi lake (8.2), Akola (16-10-68).

C. **lundellii** Delp. v. **corruptum** (Turn.) West et West

In Ramsagar lake (7.2), Tiroda (2-2-69).

C. **lundellii** Delp. v. **ellipticum** West

In a pond, Mansar (13-12-64). In Nave lake (9.5), Bhandara (19-1-69). In Nave lake (8), Sakoli (12-1-69). In a pond (8), Jawahar Nagar (12-1-69). In Ramsagar lake (7.2), Tiroda (2-2-69).

C. **maculatum** Turn.

In a pond, Umred (21-11-64). In Sarkari lake (7.2), Tumsar (22-12-68).

C. **mansangense** West et West

In Sarkari lake (7.2), Tumsar (22-12-68).

C. **margaritatum** (Lund) Roy et Bisset

In the scum on the submerged stones in Kapsi lake (8.2), Akola (16-10-68). In a pond (8), Jawahar Nagar (12-1-69).

C. **margaritatum** (Lund) Roy et Bisset f. **minor** (Boldt) West et West

In a pond, Umred (30-11-64). In a pond (8), Jawahar Nagar (12-1-69). In Mendhe lake (9.5), Bhandara (19-1-69).

C. **moniliforme** (Turp.) Ralfs v. **panduriforme** (Heimerl) Schmidle

In Abkari lake (7.5), Bhandara (29-12-68).

C. **nymannianum** Grun.

In a pond (8.2), Dahegaon (27-12-64).

C. **nymannianum** Grun. v. **brevis** (Wille) Krieger et Gerloff

In a pond, Umred (30-11-64).

C. **obsoletum** (Hantzsch) Reinsch v. **sitvense** Gutw.

In a pond, Umred (30-11-64).

C. **obtusatum** Schmidle

In a dam, Pavnar (27-10-64). In a pond, Mansar (13-12-64). In Sarkari lake (7.2), Tumsar (22-12-68). In Mendhe lake (9.5), Bhandara (19-1-69).

C. **orthostichum** Lund

In a lake (8), Yeotmal (24-11-68).

C. **orthostichum** Lund f. **subpolonica** Messik.

In a lake (8), Yeotmal (24-11-68).

C. **phaseolus** Breb. v. **achondrum** Boldt

In Sarkari lake (7.2), Tumsar (22-12-68).

C. **polonicum** Racib.

In Sarkari lake (7.2), Tumsar (22-12-68).

C. **polygonum** (Naeg.) Arch.

In a pond, Mansar (13-12-64).

C. **portianum** Arch.

In the scum on the submerged stones in Kapsi lake (8.2), Akola (16-10-68). In Sarkari lake (7.2), Tumsar (22-12-68). In Ramsagar lake (7.2), Tiroda (2-2-69).

C. **portianum** Arch. v. **nephroideum** Wittr.

In Vadali lake, Amravati (18-10-64, 20-10-69).

C. **pseudadoxum** Jao

In Chattri lake, Amravati (18-10-64).

C. **pseudoconnatum** Nordst.

In Ramsagar lake (7.2), Tiroda (2-2-69).

C. **pseudohexagonoides** Bruhl et Biswas

On the stone wall of Vadali, Amravati (18-10-64).

C. **pseudopyramidatum** Lund

In Ramsagar lake (7.2), Tiroda (2-2-69).

C. **pseudopyramidatum** Lund v. **borgei** Krieger et Gerloff

In Abkari lake (7.5), Bhandara (29-2-68). In Sarkari lake (7.2), Tumsar (22-12-68).

C. **pseudopyramidatum** Lund v. **carniolicum** Lutk.

In a lake (7.5), Tumsar (22-12-68). In a pond (8), Jawahar Nagar (12-1-69).

C. **pseudopyramidatum** Lund v. **lentiferum** Taylor

On submerged soil in Vena dam (1-2-69).

C. **pseudopyramidatum** Lund v. **rotundatum** Krieger et Gerloff

In Painganga river (8.5), Mehkar (20-10-68).

C. pyramidatum Breb.
In paddy fields, Amravati (18-10-64). In a lake (8.2), Dahegaon (27-12-64). In Vadali lake (9), Amravati (18-10-69).

C. pyramidatum Breb. v. **convexum** Krieger et Gerloff
In Vadali lake (9), Amravati (18-10-69).

C. quardratulum (Gay) De Toni
In a dam, Pavnar (27-10-64).

C. quadratum Ralfs
In Ramsagar lake (7.2), Tiroda (2-2-69).
Krieger and Gerloff (1969) include *C. quadratum* f. *major* Irenee Marie in *C. quadratum*. The present alga agrees with f. *major* in size.

C. quadratum Ralfs f. **willei** West et West
In Vadali lake, Amravati (3-3-65).

C. quadrum Lund
In Mendhe lake (9.5), Bhandara (19-1-69).

C. quinarium Lund
In Nave lake (9.2), Bhandara (19-1-69).

C. ralfsii Breb. v. **alpinum** Racib.
In Vadali lake, Amravati (18-10-64).

C. ralfsii Breb. v. **montanum** Racib.
In a pond, Umred (30-11-64).

C. rectangulare Grun. v. **africanum** West et West
In a pond, Umred (30-11-64).

C. regnellii Wille
In a lake (8.2), Dahegaon (27-12-64).

C. regnellii Wille v. **kerguelense** Krieger et Gerloff
In paddy fields, Amravati (18-10-64).

C. reniforme (Ralfs) Arch.
In a pond (8), Jawahar Nagar (12-1-69).

C. repandum Nordst. f. **minor** West et West
In Nave lake (8), Sakoli (5-1-69).

C. retusiformae (Wille) Gutw.
In a pond, Mansar (13-12-64). In Sarkari lake (7.2), Tumsar (22-12-68).

C. sexangulare Lund
In Vadali lake (9), Amravati (18-11-68).

C. sexangulare Lund f. **minimum** Nordst.
In Vadali lake (9), Amravati (18-11-68). In Abkari lake (7.5), Bhandara (25-11-68). In Ramsagar lake (7.2), Tiroda (2-2-69).

C. sikhimense Turn.
In the mucilaginous mass of *Gloeotrichia* sp. floating in Vadali lake, Amravati (18-10-64).

C. speciosum Lund v. **incrassatum** Insam et Krieger
In a pond (8), Jawahar Nagar (12-1-69).
The present alga differs from the type in having rounded apex as shown by Croasdale (1956).

C. striolatum Naeg. v. **nordstedtii** (Moeb.) Krieger
In ponds, Umred (30-11-64).

C. subacutangulum Gronbl.
In a pond (8), Jawahar Nagar (12-1-69).

C. sublatere-undateim West et West
In a pond, Umred (30-11-64).

C. subreinschii Schmid v. **ocellatum** West et West
In Vadali lake, Amravati (3-3-65).

C. subtransiens Croasdale
In Ramsagar lake (7.2), Tiroda (2-2-69).
The alga differs from the type in having 12 undulations instead of 10.

C. subtumidum Nordst.
In Vadali lake (9), Amravati (18-11-68). In Sarkari lake (7.2), Tumsar (22-12-68).

C. subtumidum Nordst. f. **minor** Krieger
In Vadali lake, Amravati (18-10-64).

C. subtumidum Nordst. v. **rotundum** Hirano
In a pond (8), Jawahar Nagar (12-1-69).

C. supraconnatum (Turn.) Krieger et Gerloff
In Abkari lake (7.5), Bhandara (29-11-68).

C. striolatum Naeg.
In Nave lake (9.5), Bhandara (19-1-69).

C. trachydermum West et West
In a streamlet, Satnavri (18-10-64).

C. trachypleurum Lund v. **nordstedtii** Gutw.
In Ramsagar lake (7.2), Tiroda (2-2-69).

C. trafalgaricum Wittr.
In a cement water passage in a garden, Wardha (12-3-68).

C. trilobatum Reinsch v. **printzii** Messik.
In a pond, Umred (30-11-64).
Umred alga agrees with Skuja's Westonian island form (Hirano 1957).

C. triplicatum Wolle
In Sarkari lake (7.2), Tumsar (22-12-68).

C. tryolicum (Nordst.) Krieger et Gerloff
In Vadali lake (9), Amravati (18-11-68).

C. tuddalense Strom
In Nave lake (8), Sakoli (5-1-69).

C. tumidum Lund
In Ramsagar lake (7.2), Tiroda (2-2-69).

C. undulatum Corda ex Ralfs
In a pond, Umred (30-11-64).

C. undulatum Corda ex Ralfs v. **crenulatum** (Naeg.) Wittr.
In a pool, Wardha (27-10-64).

C. undulatum Corda ex Ralfs v. **minutum** Wittr.
In Vadali lake, Amravati (18-10-64). In a dam, Pavnar (27-10-64). In Abkari lake (7.5), Bhandara (29-12-68). In a pond (8), Jawahar Nagar (12-1-69).

C. undulatum Corda ex Ralfs v. **wollei** W. West
In Ramsagar lake (7.2), Tiroda (2-2-69).

C. variolatum Lund v. **rotundatum** (Krieger) Messik.
In a pond (8.5), Bhandara Road (19-1-69).

C. venustum (Breb.) Arch. v. **brevis** Bernard
In a pool, Satnavri (18-10-64).

C. virde (Corda) Josh. f. **minor** W. West
In small ponds, Wardha (27-10-64).

C. virde (Corda) Josh. v. **hibernicum** (W. West) Krieger et Gerloff
In Nave lake (9.5), Bhandara (19-1-69).

C. wittrockii Lund
In Vadali lake, Amravati (18-10-64).

Euastrum bidentatum Naeg.
In a pond, Umred (30-11-64).

E. binale (Turp.) Ehrenb. v. **koreana** (Skv.) Okada
In a pond, Umred (30-11-64).

E. binale (Turp.) Ehrenb. v. **sectum** Turn.
In a lake (8.2), Dahegaon (27-12-64).

E. ceylanicum (West et West) Krieger
In Sarkari lake (7.2), Tumsar (22-12-68). In Nave lake (9.5), Bhandara (19-1-69).

E. denticulatum (Kirchn.) Gay
In a lake, Mansar (13-12-64).

E. divergens Josh. v. **ornatum** (Borge) Schm.
In Abkari lake (7.5), Bhandara (28-12-68).

E. elegans (Breb.) Kuetz. v. **pseudelegans** (Turn.) West et West
In ponds, Umred (30-11-64), Mansar (13-12-64). In Vadali lake, Amravati (3-3-65).

E. inerme (Ralfs) Lund
In Ramsagar lake (7.2), Tiroda (2-2-69).

E. insulare (Wittr.) Roy
In Vadali lake (9), Amravati (18-11-68). In Abkari lake (7.5), Bhandara (29-11-68). In a pond (8), Jawahar Nagar (12-1-69).

E. irregulare Gonz. et Gang.
In a puddle, Satnavri and in Vadali lake, Amravati (18-10-64). In pools near a dam, Pavnar (27-10-64).

E. turneri West
In Abkari lake (7.5), Bhandara (29-11-68).

E. lutkemuelleri Duc. v. **carniolicum** (Lutkem.) Krieger

In a pool, Mansar (13-12-64).

E. platycerum Reinsch

In a pond, Umred (30-11-64). In Abkari lake (7.5), Bhandara (29-11-68). In Sarkari lake (7.2), Tumsar (22-12-68).

E. spinulosum Delp.

Common in Vadali lake, Amravati (18-10-64, 3-3-65, 18-11-68). In a pond, Umred (30-11-64). In puddles, Mansar (13-12-64). In Sarkari lake (7.2), Tumsar (29-11-68). In Nave lake (8), Sakoli (5-1-69). In a pond (8), Jawahar Nagar (12-1-69). In Nave lake (9.5), Bhandara (19-1-69). In Ramsagar lake (7.2), Tiroda (2-2-69).

E. spinulosum Delp. v. **bellum** Scott et Prescott

In a pond (8), Jawahar Nagar (12-1-69).

E. subamoenum Schmidle

In Abkari lake (7.5), Bhandara (28-12-68).

E. sublobatum Breb.

In Vadali lake, Amravati (3-3-65).

E. sublobatum Breb. v. **obtusatum** (Gutw.) Krieger

In ponds, puddles, Mansar (13-12-64). In Vadali lake, Amravati (3-3-65).

E. turneri West

In Abkari lake (7.5), Bhandara (9-11-68).

Micrasterias crux-melitensis (Ehrenb.) Hass.

In Sarkari lake (7.2), Tumsar (22-12-68).

M. foliacea Bailey

In ponds, Umred (30-11-64), Mansar (13-12-64). In Ramsagar lake (7.2), Tiroda (2-2-69).

M. mahabuleshwarensis Hobs. v. **chauliodon** Scott et Prescott

Very rare. In a pond, Mansar (13-12-64).

M. pinnatifida (Kuetz.) Ralfs

In ponds, Umred (30-11-64). In Sarkari lake (7.2), Tumsar (22-12-68). In Abkari lake (7.5), Bhandara (28-12-68).

M. pinnatifida (Kuetz.) Ralfs v. **pseudoscitans** Gronbl.

In Sarkari lake (7.2), Tumsar (22-12-68).

M. radians Turn.

In ponds, Umred (30-11-64), Mansar (13-12-64). In Sarkari lake (7.2), Tumsar (22-11-68).

M. zeylanica Fritsch

In a pond, Umred (30-11-64). In Abkari lake (7.5), Bhandara (28-12-68).

M. zeylanica Fritsch v. **rectangularis** Scott et Prescott .

In Abkari lake (7.5), Bhandara (28-12-68).

Xanthidium antilopaeum (Breb.) Kuetz. v. **canadense** Joshua

In a pond, Mansar (13-12-64).

The present alga is smaller than the type—30-34 μ broad, 40-44 μ long, isthmus 20-21 μ broad.

X. antilopaeum (Breb.) Kuetz. v. **hebridarum** West et West

In a pond, Mansar (13-12-64).

X. burkillii West et West v. **alternans** Skuja

In a pond, Mansar (13-12-64).

X. hastiferum Turn.

In a pond, Mansar (13-12-64).

Arthrodesmus convergens Ehrenb.

In ponds, Mansar (13-12-64). In Ramsagar lake (7.2), Tiroda (2-2-69).

Zygotes are present in Mansar alga. They are spherical to ellipsoidal with smooth, thick outer wall, 29-31 μ in diameter, 30-34 μ long.

A. curvatus Turn.

In a pond, Mansar (13-12-64).

A. curvatus Turn. v. **latus** Scott et Prescott

In a pond, Umred (30-11-64). In Nave lake (8), Sakoli (5-1-69).

Staurastrum anatinum Cooke et Wille v. **curtum** Smith

In a Gaon lake (7.2), Sakoli (5-1-69).

S. arcuatum Nordst.

In a pond, Mansar (13-12-64).

S. brebissonii Arch. v. **truncatum** Gronbl.

In Abkari lake (7.5), Bhandara (28-12-68).

S. brevispinum Breb. v. **retusum** Smith
In Vadali lake, Amravati (18-10-64).

S. dejectum Breb.
In ponds, Umred (30-11-64), Mansar (13-12-64). In Abkari lake (7.5), Bhandara (28-12-68).

S. dickiei Ralfs
In a pond, Mansar (13-12-64).

S. gladiosum Turn.
In a pond, Umred (30-11-64).

S. gracile Ralfs
In Ramsagar lake (7.2), Tiroda (2-2-69).

S. hantzii Reinsch v. **japonicum** Roy et Bisset
In a pond, Mansar (13-12-64).

S. indentatum West et West f. **minus** Scott et Prescott
In a pond, Umred (13-12-64).

S. iotanum Wolle v. **longatus** Hirano
In a pond, Mansar (13-12-64).

S. iotanum Wolle v. **tortum** Teiling
In Vadali lake, Amravati (3-3-65). In Ramsagar lake (7.2), Tiroda (2-2-69).

S. leptodermum Lund v. **capitatum** Hirano
In ponds, Mansar (13-12-64).

S. longispinum (Bail.) Arch. v. **bidetatum** (Wittr.) West
In a pond, Mansar (13-12-64).

S. megacanthum Lund
In a pond, Mansar (13-12-64).

S. orbiculare Ralfs
In the scum on the submerged stones in Kapsi lake (8.2), Akola (16-10-68). In Ramsagar lake (7.2), Tiroda (2-2-69).

S. orbiculare Ralfs. v. **depressum** Roy et Bisset
In Vadali lake, Amravati (18-10-64). In Nave lake (9.5), Bhandara (19-1-69).

S. orbiculare Ralfs v. **ralfsii** West et West
In Sarkari lake (7.2), Tumsar (22-12-68).

S. perundulatum Gronbl.
In the scum on the submerged stones in Kapsi lake (8.2), Akola (16-10-68).

S. pinnatum Turn. v. **subpinnatum** (Schm.) West et West f. **robustum** Krieg.
In a pond, Umred (30-11-64).

S. polymorphum Breb. v. **pygmaeum** Gronbl.
In Abkari lake (7.5), Bhandara (28-12-68).

S. punctulatum Breb.
In puddles, Umred (30-11-64). In Vadali lake, Amravati (3-3-65).

S. quadricornutum Roy et Bisset
Rare. In Vadali lake, Amravati (3-3-65).

S. retusum Turn. v. **boreale** West et West
In Vadali lake, Amravati (3-3-65).

S. saltans Josh. v. **javanicum** Scott et Prescott
In a pool, Umred, (30-11-64).

S. sexangulare (Bulnh.) Lund
In a pond, Umred (30-11-64).

S. sexangulare (Bulnh.) Lund v. **crassum** Turn.
In a pond, Umred (30-11-64).

S. tohopekaligense Wolle
In a pool, Mansar (13-12-64).

S. tohopekaligense Wolle v. **insigne** West et West
In puddles, Mansar (13-12-64).

S. unguiferum Turn.
In ponds, Umred (30-11-64), Mansar (13-12-64).

Sphaerozosma punctatum West et West
In a pond, Umred (30-11-64).

S. vertebratum (Breb.) Ralfs
In ponds, Umred (30-11-64).

Spondylosium nitens (Wall.) Arch. f. **majus** Turn.
In a pond, Umred (30-11-64).

S. planum (Wolle) West et West
In ponds, Umred (30-11-64), Mansar (13-12-64).

Onychonema laeve Nordst. v. **latum** West et West
In ponds, Umred (30-11-64), Mansar (13-12-64). In Ramsagar lake (7.2), Tiroda (2-2-69).

O. laeve Nordst. v. **micracanthum** Nordst.
In a pond, Umred (30-11-64).

Hyalotheca dissiliens (Smith) Breb.
In Vadali lake, Amravati (3-3-65).
H. indica Turn.
In Ramsagar lake (7.2), Tiroda (2-2-69).
H. mucosa (Mert.) Ehrenb.
In a pond, Umred (30-11-64).
H. undulatum Nordst.
Rare. In Vadali lake, Amravati (13-12-64).
Desmidium aptogonum Breb.
In Vadali lake, Amravati (3-3-65).
D. aptogonum Breb. v. **ehrenbergii** Kuetz.
In paddy fields, Amravati (18-10-64). In Ramala lake, Chandrapur (1-11-64). In Nave lake (9.5), Bhandara (19-1-69).
D. pseudostreptonema West et West
Common in ponds, Umred (30-11-64). In Ramsagar lake (7.2), Tiroda (2-2-69).

Aplanospores are observed in material from Ramsagar lake. They are globose, 16 μ broad, with smooth wall.

D. quadratum Nordst.
In Ramsagar lake (7.2), Tiroda (2-2-69).
Streptonema trilobatum Wall.
In ponds, Umred (30-11-64). In Ramsagar lake (7.2), Tiroda (2-2-69).
Zygotes are observed in Ramsagar material. Zygotes are 33-35 μ broad, 50-53 μ long, ellipsoid in shape and with smooth walls.
Mougeotia banglorensis Iyengar
In paddy fields, Vadali lake, Amravati (18-10-64).
Aplanospores are also present.
M. calcarea (Cleve) Wittr.
In a puddle, Amravati (18-10-64).
M. floridana Transeau
In Kapsi lake (8.2), Akola (16-10-68).
M. maltae Skuja
In Ramsagar lake (7.2), Tiroda (2-2-69).
M. microspora Taft
In a pond, Mansar (13-12-64).
M. reinschii Transeau
In a pond, Amravati (18-10-64).
M. sphaerocarpa Wolle
In Sarkari lake (7.2), Tumsar (22-12-68).
M. transeau Collins
In Ramsagar lake (7.2), Tiroda (2-2-69).
Zygnema czurdae Randhawa
In Vadali lake, Amravati (18-10-64). In Ramsagar lake (7.2), Tiroda (2-2-69).
Z. gangeticum Rao
In Ramsagar lake (7.2), Tiroda (2-2-69).
Z. globosum Czurda
In Vadali lake, Amravati (3-3-65).
Zygnemopsis minuta Randhawa
In Vadali lake, Amravati (3-3-65).
The present alga is provisionally kept here as the zygospores and azygospores differ from the type in having smooth walls and horned zygospores not observed.
Z. sphaerospora Randhawa
In Abkari lake (7.5), Bhandara (29-12-68).
Vegetative cells bigger—up to 21 μ broad, 150 μ long.
Spirogyra azygospora R. N. Singh
In Khamb lake (8), Tiroda (2-2-69).
S. bichromatophora (Randhawa) Transeau
In Kapsi lake (8.2), Akola (16-10-68).
S. biformis Jao
In a pond, Wardha (12-3-68).
Lateral conjugation only observed.
S. corrugata Transeau
In Ramsagar lake (7.2), Tiroda (2-2-69).
S. diluta Wood
In a streamlet, Satnavri (18-10-64).
S. fennica Cedercreutz
In Ramsagar lake (7.2), Tiroda (2-2-69).
Chloroplast makes four turns.
S. fuellebornei Schmidle
In a dam, Pavnar (27-10-64).
S. smithii Transeau
In Zarpat stream, Chandrapur (1-11-65).
S. weberi Kuetz.
In paddy fields, Amravati (18-10-64).

EUGLENOPHYCEAE

Euglena acus Ehrenb.
In bodhans, Chandrapur (1-11-65). In a pond, Umred (30-11-66).
E. acus Ehrenb. v. **hyalina** Klebs
In a gutter, Khamgaon (13-10-67).
E. acus Ehrenb. v. **oyei** Defl.
In a bodhan, Amravati (18-10-64).
E. acus Ehrenb. v. **rigida** Hubner
In a foul smelling pool, Chandrapur (1-11-65).
E. allorgei Defl.
In a bodhan, Akola (10-10-68).
E. caudata Hubner
In a bodhan, Akola (18-10-68).
E. charkowiensis Swir.
In a pool near a gutter, Chandrapur (1-11-65). In a bodhan, Akola (16-10-68). In Mendhe lake (9.5), Bhandara (19-1-69).
E. charkowiensis Swir. v. **minor** Skovortz.
In Zarpat stream, Chandrapur (1-11-65).
E. chortes Schiller
In a pond, Umred (30-11-64). In Nursery pond (8), Bhandara (28-12-68).
E. gaumeri Allorge et Lefevre
In a bodhan, Amravati (18-10-64).
E. gracilis Klebs
In a bodhan, Umred (30-11-64). In a pool, Khamgaon (13-10-67).
E. ignobilis L. P. Johnson
In a bodhan, Akola (16-10-68).
E. limnophila Lemm.
In a pool, Satnavri (18-10-64).
E. mucifera Mainx
In a pond, Umred (30-11-64).
E. multiformis Schiller
In a bodhan (8.4), Akola (16-10-68).
E. oxyuris Schmarda
In a pond, Umred (30-11-64). In a gutter, Khamgaon (13-10-67).
E. pusilla Playfair
In a pond, Umred (30-11-64).
E. spirogyra Ehrenb.
In a pond, Umred (30-11-64).
E. spirogyra Ehrenb. v. **suprema** Skuja
In a puddle, Mansar (13-12-64). In Sarkari lake (7.2), Tumsar (22-12-68).
E. tripteris (Duj.) Klebs
In a puddle, Umred (30-11-64).
Phacus acuminatus Stokes v. **indica** (Pochm.) Huber-Pestalozzi
In a bodhan, Amravati (18-10-64). In a pool, Umred (30-11-64).
P. acuminatus Stokes v. **variabilis** Lemm.
In bodhans, Amravati (18-10-64). Umred (30-11-64), Mansar (13-12-64).
P. angulatus Pochm.
In Nursery pond (8), Bhandara (28-12-68).
P. caudatus Hubner
In a pond, Umred (30-11-64).
P. circumflexus Pochm.
In a pond, Umred (30-11-64).
P. contortus Bourr.
In a puddle, Umred (30-11-64).
P. curvicauda Swir.
In bodhans, Amravati (18-10-64), Wardha (27-10-64), Umred (30-11-68).
P. sphippion Pochm.
In Ramala lake, Chandrapur (1-11-65).
P. longicauda (E.) Duj. v. **major** Swirenko
In a pool, Umred (30-11-64).
P. longicauda (E.) Duj. v. **rotunda** (Pochm.) Huber-Pestal.
In bodhans, Amravati (18-10-64), Chandrapur (1-11-64), Akola (16-10-68). In Ramala lake, Chandrapur (11-10-68). In Sarkari lake (7.2), Tumsar (22-12-68).
P. mangini Lef.
In a bodhan, Akola (16-10-68).
P. minutus (Playf.) Pochm.
In a pool, Satnavri (18-10-64). In Khamb lake (9), Bhandara (28-12-68).
P. orbicularis Hubn.
In a pond, Umred (30-11-64). In Januna lake (8.2), Khamgaon (13-10-67). In Mendhe lake (9.5), Bhandara (19-1-69).

P. pekinensis Skvortz.
In Januna lake (8.2), Khamgaon (13-10-67).
P. platalea Drez.
In bodhans, Amravati (18-10-64), Umred (30-11-64), Mansar (13-12-64), Akola (16-10-68), Bhandara (22-12-68). In Nursery pond (8), Bhandara (28-12-68).
P. pleuronectes (O.F.M.) Duj.
In Motha lake, Umred (30-11-64).
P. pseudonordstedtii Pochm.
In a puddle, Umred (30-11-64).
P. stokesii Lemm. f. **minor** Conrad
In a pond, Wardha (27-10-64).
P. swirenkoi Ekvortz.
In a pool, Wardha (27-10-64).
P. thrombus Pochm.
In a pool, Umred (30-11-64).
P. tortus (Lemm.) Skv.
In a bodhan, Amravati (18-10-64). In Nursery pond (8), Bhandara (28-12-68).
Trachelomonas allia Drez. em. Defl.
In a streamlet, Satnavri (18-10-64). In a pond, Umred (30-11-64). In Mendhe lake (9.5), Bhandara (19-1-69).
T. armata (E.) Stein
In a pond, Umred (30-11-64).
T. armata (E.) Stein v. **longispina** Playf.
In a puddle, Umred (30-11-64).
T. armata (E.) Stein v. **steinii** Lemm. em. Defl.
In Vadali lake, Amravati (18-10-64). In a streamlet, Satnavri (6-12-64). In a puddle, Mansar (13-12-64). In Nursery pond (8), Bhandara (28-12-68).
T. bacillifera Playf.
In a bodhan, Chandrapur (1-11-65).
T. bacillifera Playf. v. **minima** Playf.
In Abkari lake (7.5), Bhandara (29-12-68). In Mendhe lake (9.5), Bhandara (19-1-69).
T. bernardinensis W. Vischer em. Defl.
In a bodhan, Akola (16-10-68).
Tests bigger—22 to 26 μ broad, 55 to 58 μ long.
T. conica Playf.
In Ramala lake, Chandrapur (1-11-64).
T. cylindrica E. sec. Playf. v. **decollata** Playf.
In a bodhan, Amravati (18-10-64).
T. dubia Swir. em. Defl. v. **lata** Defl.
In a puddle, Mansar (13-12-64).
T. dybowskii Drez.
In a pond (8.5), Bhandara Road (19-1-69).
T. globularis Lemm. (Awer.) v. **boyeri** (Palmer) Conr.
In a pond, Mansar (13-12-64). In Abkari lake (7.5), Bhandara (28-12-68).
T. hispida (Perty) Stein em. Defl.
In paddy fields, Amravati (18-10-64). In Vadali lake, Amravati (18-10-64, 3-3-65). In bodhans, Chanda (1-11-64), Umred (30-11-64), Mansar (13-12-64), Malegaon (16-10-68). In Sarkari lake (7.2), Tumsar (22-12-68). In Abkari lake (7.5), Bhandara (29-12-68). In Mendhe lake (9.5), Bhandara (19-1-69).
T. hispida (Perty) Stein em. Defl. f. **recta** Defl.
In Abkari lake (7.5), Bhandara (29-12-68).
T. hispida (Perty) Stein em. Defl. v. **coronata** Lemm.
In paddy fields, Amravati (18-10-64).
T. incertissima Defl.
In bodhans, Amravati (18-10-64). In Vadali lake, Amravati (3-3-65).
T. intermedia Dangeard
In a pond, Mansar (13-12-64). In a pond (8.5), Bhandara Road (19-1-69).
T. klebsii (Klebs) Defl.
In Vadali lake, Amravati (3-3-65). In bodhans, Akola (10-10-68). In Khamb lake (9), Bhandara (28-12-68). In Ramsagar lake (7.2), Tiroda (2-2-69).
T. lacustris Drez.
In a bodhan, Malegaon (11-10-68). In Sarkari lake (7.2), Tumsar (22-12-68).

T. mangini Defl.
In Nursery pond (8), Bhandara (28-12-68).

T. mucosa Swir. v. **hyalina** Skv.
In a bodhan, Chandrapur (1-11-65).

T. oblonga Lemm.
In a bodhan, Akola (16-10-68). In a pool, Malegaon (20-10-68). In a bodhan, Mansar (20-11-68). In Khamb lake (9), Bhandara (28-12-68). In a pond (8.5), Bhandara Road (19-1-69).

T. oblonga Lemm. v. **australica** Playf.
In a bodhan, Chandrapur (1-11-64). In a pond, Mansar (13-12-64).

T. oblonga Lemm. v. **major** Kamat
In a pond, Umred (30-11-64).

T. oblonga Lemm. v. **truncata** Lemm.
In a bodhan, Warora (2-11-65). In a pond, Mansar (12-11-67).

T. obtusa Palmer
In a pond, Umred (30-11-64).

T. perforata Awering
In Nursery pond (8), Bhandara (28-12-68).

T. piscatoris (Fischer) Stokes
In a bodhan, Chandrapur (1-11-65.)

T. playfairi Defl.
In ponds, Umred (30-11-64).

T. pulcherrima Playf. v. **minor** Playf.
In a bodhan, Amravati (18-10-64). In a pond, Mansar (13-12-64).

T. raciborskii Wolosz.
In Abkari lake (7.5), Bhandara (19-12-68).

T. robusta Swir. em. Defl.
In Mendhe lake (9.5), Bhandara (19-1-69).

T. scabra Playf.
In a bodhan, Amravati (18-10-65).

T. scabra Playf. v. **ovata** Playf.
In bodhans, Amravati (18-10-64).

T. similis Stokes
In Nursery pond (8), Bhandara (28-12-68).

T. superba Swir. em Defl.
In Sarkari lake (7.2), Tumsar (22-12-68).

T. sydneyensis Playf.
In Abkari lake (7.5), Bhandara (29-12-68).

T. varians Defl.
In a pond, Umred (30-11-64). In Nursery pond (8), Bhandara (28-12-68).

T. volvocina Ehrenb.
In bodhans, Amravati (18-10-64), Wardha (22-10-64), Umred (30-11-64), Mansar (13-12-64), Chandrapur (1-11-65), Gondia (5-3-67), Khamgaon (13-10-67). In Nursery pond (8), Bhandara (28-12-68). In Sarkari lake (7.2), Tumsar (22-12-68). In Mendhe lake (9.5), Bhandara (19-1-69). In a pond (8.5), Bhandara Road (19-1-69). In Ramsagar lake (7.2), Tiroda (2-2-69).

T. volvocina Ehrenb. f. **minuta** Fritsch
In a bodhan, Amravati (18-10-64).

T. volvocina Ehrenb. v. **derephora** Conrad
In a pond, Mansar (13-12-64). In Sarkari lake (7.2), Tumsar (22-12-68).

T. volzii Lemm. v. **cylindrica** Playf.
In a pond, Umred (30-11-64).

T. volzii Lemm. v. **pellucida** Playf.
In pools, Umred (30-11-64).

T. wermelii Skv.
In Nursery pond (8), Bhandara (28-12-68).

T. woycickii Koczwara v. **bombayensis** Kamat
In a pond, Mansar (13-12-64).

T. woycickii Koczwara v. **pusilla** Drez.
In a bodhan, Amravati (18-10-64).

Strombomonas fluviatilis (Lemm.) Defl.
In Nursery pond (8), Bhandara (28-12-68).

S. maxima (Skv.) Defl.
In a bodhan, Chandrapur (1-11-64).

S. napiformis (Playf.) Defl. v. **brevicollis** (Playf.) Defl.
In Nursery pond (8), Bhandara (28-12-68).

S. ovalis (Playf.) Defl.
In a bodhan, Chandrapur (1-11-65). Wall finely punctuate.

S. urceolata (Stokes) Defl.
In a bodhan, Amravati (3-3-65).

Lepocinclis glabra Drez. f. **minor** Prescott
In a bodhan, Amravati (18-10-64).

L. marssonii Lemm. em Conrad
In Sarkari lake (7.2), Tumsar (22-12-68).

Menoidium gracile Playf.
In a puddle, Umred (30-11-64).

Anisonema acus Duj.
In a pond, Mansar (13-12-64).

XANTHOPHYCEAE

Ophiocytium elongatum West et West
In a puddle, Umred (30-11-64).

Botrydium granulatum (L.) Greville
On the moist soil of a drying puddle, Satnavri (18-10-64). On moist soil near a pond, Gondia (5-3-67). On the moist soil of a drying pool, Sakoli (15-12-68).

DINOPHYCEAE

Cystodinium iners Geitler
In a pond, Mansar (13-12-64).

Massartia stigmatica (Linden) Schiller
In Vadali lake, Amravati (3-3-65). In Ramsagar lake (7.2), Tiroda (2-2-69).

Gymnodinium neglectum (Schill.) Lind.
In a puddle, Mansar (13-12-64).

G. rotundum Klebs
Planktonic in Khamb lake (9), Bhandara (28-12-68).

Glenodinium gymnodinium Penard
Planktonic in a pond (8.2), Katol (24-11-68).

G. quadridens (Stein.) Schiller
Planktonic in Khamb lake (8), Tiroda (2-2-69).

Peridinium bipes Stein
In Sarkari lake (7.2), Tumsar (22-12-68).

P. cinctum (Muell.) Ehrenb.
In Ramala lake, Chandrapur (1-11-65).

P. palustre (Lindem.) Lef. v. **raciborskii** (Wol.) Lef.
In Abkari lake (7.2), Bhandara (29-11-68).

P. penardiforme Lindem.
In Ramsagar lake (7.2), Tiroda (2-2-69).

P. pusillum (Penard) Lemm.
In a cement cistern, Amravati (18-10-64).

CYANOPHYCEAE

Microcystis aeruginosa Kuetz.
Planktonic in a pond (9.2), Tumsar (22-12-68). In Nursery pond (8), Bhandara (28-12-68). In Khamb lake (8.5), Tiroda (2-2-69).

M. flos-aquae (Wittr.) Kirchn.
Planktonic in ponds, Gondia (5-3-67), Mehkar (20-10-68), Tumsar (22-12-68).

Aphanocapsa grevillei (Hass.) Rabenh.
On stones in pools, Satnavri (18-10-64). On submerged soil at the shore of Vena dam (1-2-69).

A. testacea Naeg.
In Ramsagar lake (7.2), Tiroda (2-2-69).
The alga is free floating and the cells are spherical and never ellipsoid as in the type.

Aphanothece castagnei (Breb.) Rabenh.
In cement cisterns, Khamgaon (13-10-68). In Nave lake (9.5), Bhandara (28-12-68).

A. heterospora Rabenh.
In Ramsagar lake (7.5), Tiroda (2-2-69).

A. microscopica Naeg.

Adhering to sides of cement cisterns, Amravati (18-10-64). In Ramala lake, Chandrapur (1-11-64). In Nave lake (9.5), Bhandara (19-1-69). In Rasmagar lake (7.2), Tiroda (2-2-69).

A. pallida (Kuetz.) Rabenh.

In Vadali lake and on moist soil, Amravati (18-10-64). In paddy fields, Umred (30-11-64). On moist soil and in ponds, Mansar (13-12-64). On moist soil in a garden, Chandrapur (1-11-65). On moist soil and in cement cisterns, Khamgaon (13-10-67). On moist soil of a drying pool, Akola (16-10-68). In Nave lake (9.5), Bhandara (19-1-69). In Ramsagar lake (7.2), Tiroda (2-2-69).

Firm, globular to elongate, yellowish mucilaginous masses, 3-8 cm broad, were present in large numbers in paddy fields in Umred.

In some collections, cells with sheaths—*Gloeothece* like cells were present.

Gloeocapsa muralis Kuetz.

Adhering to the sides of a cement cistern, Amravati (18-10-68).

Gloeothece geoppertiana (Hilse) Forti

In a cement water passage, Wardha (12-3-68).

G. rupestris (Lyngby.) Born.

In a pool, Khamgaon (13-10-67).

G. samoensis Wille

In a cement cistern, Amravati (18-10-64). In Ramsagar lake (7.2), Tiroda (2-2-69).

Chroococcus minor (Kuetz.) Naeg.

In cement cisterns, Amravati (18-10-64). In Ramsagar lake (7.2), Tiroda (2-2-69).

C. minutus (Kuetz.) Naeg.

In a streamlet, Satnavri (18-10-64). In pools, puddles, Wardha (27-10-64), Khamgaon (13-10-67).

C. minutus (Kuetz.) Naeg. v. **obliteratus** (Richt.) Hansg.

In the scum on the stones submerged in Kapsi lake (8.2), Akola (16-10-68).

C. pallidus Naeg.

In a puddle, Wardha (27-10-64).

C. spelaeus Ercegovic

In Ramsagar lake (7.2), Tiroda (2-2-69).

C. turgidus (Kuetz.) Naeg.

In a pond, Wardha (27-10-64). In Ramsagar lake (7.2), Tiroda (2-2-69).

C. turgidus (Kuetz.) Naeg. v. **maximus** Nygaard

In Ramsagar lake (7.2), Tiroda (2-2-69).

C. turicensis (Naeg.) Hansg.

In cement cisterns, Amravati (18-10-64). In a lake (8.2), Dahegaon (27-12-64). In Januna lake (8.2), Khamgaon (13-10-67).

C. westii (W. West) Boye-Pet.

In a lake (8), Yeotmal (27-10-68). In Sarkari lake (7.2), Tumsar (22-12-68). In Nave lake (9.5), Bhandara (19-1-69).

Merismopedia elegans A. Br.

In puddles, Wardha (27-10-64), Mehkar (20-10-68). In Ramsagar lake (7.2), Tiroda (2-2-69).

M. glauca (Ehrenb.) Naeg.

In a streamlet, Satnavri (18-10-64). In cement cisterns, Amravati (18-10-64), Wardha (27-10-64). In a pond (8.5), Jawahar Nagar (12-1-69). In a side pool of Vena dam (1-2-69). In Khamb lake (8.5), Tiroda (2-2-69).

M. punctata Meyen

In a dam, Pavnar (27-10-64). In Zarpat stream, Chandrapur (1-11-64). In a pond, Wardha (10-11-65). In Painganga river (8.2), Mehkar (20-10-68). In Nave lake (8), Sakoli (15-12-68).

M. tenuissima Lemm.

In cement cisterns, Amravati (18-10-64).

Colonies usually consisting of 4-8 cells. Cells broader—up to 3 μ broad.

Synechococcus cedrorum Sauv.

In cement cisterns, Amravati (18-10-64).

S. aquatilis Sauv.

In a pool, Amravati (18-10-64).

S. crassa Woronic.

In a cement cistern, Amravati (18-10-64).

S. sallensis Skuja
In a cement cistern, Amravati (18-10-64).
Myxosarcina burmensis Skuja
In Abkari lake (7.5), Bhandara (28-12-68). In Ramsagar lake (7.2), Tiroda (2-2-69).
M. spectabilis Geitler
In a pond, Umred (30-11-64).
Chamaesiphon sideriphilus Starm. v. **glabra** C. B. Rao
In a lake (8), Yeotmal (24-11-68). Calcium impregnation is not present.
Borzia trilocularis Cohn
In cement cisterns, Amravati (18-10-64). Khamgaon (13-10-67).
Spirulina major Kuetz. ex Gomont
In Vadali lake, Amravati (18-10-64). In a pool, Satnavri (18-10-64). In Pavnar dam (27-10-64). In a puddle and in a gutter, Wardha (27-10-64). In Ramala lake, in a pool and in a bodhan, Chandrapur (1-11-64). In a pond, Gondia (5-3-67). In a lake (11), Lonar (24-10-68). In Zarpat stream, Chandrapur (12-10-69). In a lake (8), Yeotmal (24-11-68). In Khamb lake (8.5), Tiroda (2-2-69).
S. meneghiniana Zanard
In a pond, Wardha (27-10-64). In a lake (11), Lonar (24-10-68).
S. princeps West et West
In Sarkari lake (7.2), Tumsar (22-12-68).
S. subsalsa Oerst.
In a rock pool, Wardha (27-10-64).
S. subsalsa Oerst. v. **crassior** Virieux
In a lake (11), Lonar (24-10-68). Spirals up to 4 μ broad only.
Arthrospira platensis (Nordst.) Gomont
In a lake (8), Yeotmal (24-11-68).
A. tenuis Bruhl et Biswas
In a bodhan, Amravati (18-10-64). Trichomes usually much longer, with 10 spirals.
Oscillatoria agardhii Gom.
In a pond, Gondia (5-3-67).
O. amphibia Ag. ex Gom.
In a dirty water passage, Wardha (27-10-64). In ponds, Mansar (13-12-64), Gondia (5-3-67), Tumsar (22-12-68). At the shore of a lake (11), Lonar (24-10-68).
O. angusta Koppe
In a streamlet, Satnavri (18-10-64).
O. annae van Goor
In a puddle, Wardha (27-10-64).
O. boryana Bory ex Gom.
In a lake (8), Yeotmal (24-11-68).
O. brevis (Kuetz.) Gom.
In gutters and side pools, Akola (16-10-68), Khamgaon (13-10-67). In Ramsagar lake (7.2), Tiroda (2-2-69).
O. chalybea (Mertens) Gom.
In a pond, Amravati (18-10-64). In a pond (8), Akola (16-10-68). In a lake (11), Lonar (24-10-68).
O. claricentrosa Gardn.
In the mucilaginous masses of other algae in a pond, Umred (30-11-64).
O. cortiana Menegh.
In a gutter, Wardha (27-10-64).
O. cortiana Menegh. v. **minor** Kamat
In a puddle, Chandrapur (1-11-65).
O. decolorata G. S. West
In a pond, Umred (30-11-64).
O. formosa Bory ex Gom.
In a cement cistern, Amravati (18-10-64).
O. geminata Menegh. ex Gom.
In a lake (8.2), Katol (8-12-68).
Trichomes narrower up to 2 μ broad.
O. jasorvensis Vouk
In Ramsagar lake (7.2), Tiroda (2-2-69).
O. mougeotii Kuetz.
In a streamlet, Satnavri (18-10-64). In a pond and in gutters, Umred (30-11-64). In gutters, Akola (16-10-68), Karanja (17-10-68), Mehkar (22-10-68). In a lake (8), Yeotmal (24-11-68). In Sarkari lake (7.2), Tumsar (22-12-68).
O. nigro-viridis Thwaites
On moist soil near a gutter, Wardha (12-3-68).
O. okeni Ag. ex Gom.
In Pavnar dam (27-10-64). In a gutter and in Januna lake (8.2), Khamgaon (13-10-67). On the shore of a lake (11), Lonar (24-10-68). In a lake (8), Yeotmal (24-11-68). In

Sarkari lake (7.2), Tumsar (22-12-68).

O. ornata Kuetz. ex Gom. v. **crassa** C. B. Rao

In a pond, Wardha (27-10-64). In Zarpat stream, Chandrapur (1-11-64). In a pond, Gondia (5-3-67).

O. princeps Vauch.

In a rock pool, Wardha (27-10-64).

O. proboscoidea Gom.

In a bodhan, Satnavri (18-10-64). In a pool, Wardha (27-10-64).

O. profunda Kirchn.

In a pond, Gondia (5-3-67). On moist soil near Vena dam (1-2-69). In a road side puddle, Tiroda (2-2-69).

O. pseudogeminata G. Schmid

In a puddle, Amravati (18-10-64). In a streamlet, Satnavri (18-10-64).

O. pseudogeminata G. Schmid f. **longa** Kamat

In a pool, Satnavri (18-10-64). In Zarpat stream, Chandrapur (1-11-64). On moist soil near a pond and in Kapsi lake (8.2), Akola (16-10-68). In a lake (11), Lonar (24-10-68). In Khamb lake (8.5), Tiroda (2-2-69).

Occasionally the trichomes are broader—up to 2.8 μ broad.

O. quadripunctulata Bruhl et Biswas

Embedded in the mucilaginous masses of *Gloeotrichia* sp. in Gaon lake (7.2), Sakoli (5-1-69).

O. quadripunctulata Bruhl et Biswas v. **unigranulata** R. N. Singh

In a streamlet, Satnavri (18-10-64).

O. quadripunctulata Bruhl et Biswas v. **unigranulata** R. N. Singh. f. **ahmedabadensis** Kamat

In paddy fields, Umred (30-11-64). On the shore of Vena dam (1-2-69).

O. raciborskii Wolosz.

In Nursery pond (8), Bhandara (28-12-68).

Trichomes slightly broader—up to 10 μ broad.

O. rubescens D. C. ex Gomont

In gutters, Amravati (18-10-64), Umred (30-11-64), Akola (16-10-68), Mehkar (20-10-68), Yeotmal (24-11-68). In Ramsagar lake (7.2), Tiroda (2-2-69).

O. schultzii Lemm. v. **cylindrica** Kamat

On moist soil near a pond, Wardha (27-10-64). In Zarpat stream, Chandrapur (1-11-64).

Trichomes slightly broader—up to 3.5 μ broad.

O. simplicissima Gom.

In Sarkari lake (7.2), Tumsar (22-12-68).

O. splendida Grev. ex Gom.

In a pool, Satnavri (18-10-64). In Gaon lake (7.2), Sakoli (7-1-69). In Ramsagar lake (7.2), and Belati pond (7.5), Tiroda (2-2-69).

Belati pond alga is broader—up to 3.6 μ broad.

O. splendida Grev. ex Gom. v. **attenuata** West et West

On moist soil near Vena dam (1-2-69).

O. subuliformis Kuetz. ex Gom.

On drying soil near a lake (11), Lonar (24-10-68).

Trichomes broader—up to 7.5 μ broad.

O. tambi Woron.

In a bodhan, Amravati (18-10-64). In a lake (11), Lonar (24-10-68).

Amravati alga has slightly constricted trichomes while Lonar alga has narrower trichomes (– 2.9 μ broad).

O. tenuis Ag. v. **tergestina** Rabenh.

In a lake (8), Yeotmal (24-11-68).

O. ulrichii Prat

Planktonic in a bodhan, Gondia (5-3-67).

Phormidium corium (Ag.) Gom.

In Vadali lake, Amravati (18-10-64). In a streamlet, Satnavri (18-10-64).

P. crossbyanum Tild.

On cement flooring near a water tap, Tiroda (2-2-69).

P. foveolarum Gom.

In Zarpat stream, Chandrapur (1-11-64).

P. frigidum Fritsch

On the sides of cement cisterns, Amravati (18-10-64).

P. jenkelianum G. Schmid
In a streamlet, Satnavri (18-10-64).
P. molle Gom.
In Vadali lake, Amravati (13-10-64). In a pool, Wardha (27-10-64).
P. mucicola Huber-Pest. et Naumann
Embedded in the mucilage of *Microcystis* colonies in Nursery pond (8), Bhandara (28-12-68), in a pond (9), Tumsar (22-12-68), in Khamb lake (8.5), Tiroda (2-2-69).
P. stagnina C. B. Rao
On dripping rocks, Chandrapur (1-11-64). Near a water tap, Wardha (2-3-68).
Lyngbya allorgei Fremy v. **granulata** Kamat
On stones in a streamlet, Satnavri (18-10-64).
Filaments are narrower, 3-3.2 μ broad and the cells sometimes longer —up to 5 μ long.
L. birgei G. M. Smith
In Sarkari lake (7.2), Tumsar (22-12-68).
L. confervoides Ag.
Adhering to cement drain, Wardha (12-3-68).
L. endophytica Elenk. et Hollerb.
In mucilaginous masses of *Aphanothece* in paddy fields, Umred (30-11-64).
L. gandhii Kamat
In a fountain reservoir, Amravati (18-10-64).
L. hieronymusii Lemm.
In a pond, Umred (30-11-64).
L. holsatica Lemm.
Floating masses in a pond, Wardha (27-10-64).
L. lachneri (Zimm.) Geitler
In a cement cistern, Amravati (18-10-64). In a lake (8), Yeotmal (22-11-68). In Nave lake (9.5), Bhandara (19-1-69).
L. lachneri (Zimm.) Geitler v. **minor** Geitler
On cement flooring near a water tap, Tiroda (2-2-69).
L. limnetica Lemm.
In Ramsagar lake (7.2), Tiroda (2-2-69).
L. majuscula Harvey ex Gomont
In a streamlet, Satnavri (18-10-64). In Pavnar dam (27-10-64).
L. martensiana Menegh. ex Gomont
In a streamlet, Chandrapur (1-11-64).
Trichomes slightly narrower—up to 5.8-6 μ broad.
L. shackletoni West et West
On cement flooring near a water tap and in Ramsagar lake (7.2), Tiroda (2-2-69).
L. spiralis Geitler
In a bodhan, Satnavri (18-10-64).
Microcoleus chthonoplastes Thuret ex Gomont
On moist soil near Nave lake, Sakoli (5-1-69).
Anabaenopsis arnoldii Aptek. v. **indica** Ramnathan
Planktonic in a lake (11), Lonar (24-10-68).
Spores not observed.
A. circularis (G. S. West) Wolosz. et Miller
Planktonic in a puddle, Mehkar (20-10-68).
Heterocysts are conical and not spherical as in the type. Granules and/or gas-vacuoles are not observed.
A. raciborskii Wolosz.
Planktonic in ponds, Gondia (5-3-67), Mehkar (20-10-68).
Trichomes are slightly constricted in both the collections, which agree with the description given by Geitler (1932). Desikachary (1959) describes the trichomes as not constricted though his figure (Pl. 63, f. 7) shows slight constrictions at some cross walls.
Raphidiopsis mediterranea Skuja
Planktonic in ponds, Mansar (13-12-64), Gondia (5-7-67), Katol (8-12-68).
Cylindrospermum licheniforme Kuetz. ex Born. et Flah.
In Vadali lake, Amravati (3-3-65).
C. majus Kuetzing ex Born. et Flah.
In paddy fields, Amravati (18-10-64).

C. muscicola Kuetz. ex Born. et Flah.
In Nave lake (9.5), Bhandara (19-1-69).

C. stagnale (Kuetz.) Born. et Flah.
In Vadali lake, Amravati (3-3-65). In Ramsagar lake (7.2), Tiroda (2-2-69).

Anabaena fuellebornii Schmidle
In Sarkari lake (7.2), Tumsar (23-12-68).

A. ineaqualis (Kuetz.) Born. et Flah.
In a pond, Umred (30-11-64).

A. orientalis Dixit
In Sarkari lake (7.2), Tumsar (22-12-68).

A. sphaerica Born. et Flah.
Planktonic in a puddle, Mehkar (20-10-68).

A. volzii Lemm.
In paddy fields, Amravati (13-10-64). In a small pond, Wardha (27-10-64). In Ramsagar lake (7.2), Tiroda (2-2-69).

Nodularia spumigena Mertens
In a lake (11), Lonar (24-10-68).

Nostoc microscopicum Carm. ex Born. et Flah.
In Nursery pond (8), Bhandara (28-12-68).
Spores not observed.

N. paludosum Kuetz. ex Born. et Flah.
In a pond, Umred (30-11-64). In Abkari lake (7.5), Bhandara (29-11-68).

N. rivulare Kuetz. ex Born. et Flah.
In Gaon lake (7.2), Sakoli (5-1-69).

Aulosira fertilissima Ghose v. **tenuis** C. B. Rao
In Vadali lake and in paddy fields, Amravati (18-10-64). In Kapsi lake (8.2), Akola (16-10-68).

A. implexa Born. et Flah. v. **crassa** Dixit
In Vadali lake, Amravati (18-10-64). In a streamlet, Warora (30-10-65). In a pool, Chandrapur (1-11-65).

Camptylonemopsis pulneyensis Desik.
In Sarkari lake (7.2), Tumsar (22-12-68).
Filaments up to 16 μ broad; spores are cylindric, 12-14 μ broad, 16-20 μ long, with smooth walls.

Scytonema chiastum Geitler
In paddy fields, Amravati (18-10-64).

S. cookei W. et G. S. West
On moist soil, Amravati (18-10-64).

S. simplex Bharadw.
In Ramsagar lake (7.2), Tiroda (2-2-69).

Fortiea bossei (Fremy) Desik.
In a streamlet, Amravati (18-10-64; 20-11-68).
Spores broader up to 6.5 μ broad, the shape of the spores also different being always rectangular, and not rounded at the angles.

Calothrix clavatoides Ghose
Epiphytic on *Hydrilla* leaves in a cement cistern, Akola (6-3-69).

C. epiphytica West et West
In Sarkari lake (7.2), Tumsar (22-12-68).

C. karnatakensis Gonz. et Kam. v. **major** Gonz. et Kam.
Epiphytic on aquatic plants in Vadali lake, Amravati (3-3-65).

C. marchica Lemm.
In Abkari lake (7.5), Bhandara (29-12-68).

C. wembaerensis Hieron et Schmidle
In Sarkari lake (7.5), Tumsar (22-12-68).

Dichothrix orsiniana (Kuetz.) Born. et Flah.
On dripping rocks, Amravati (18-10-64).

Gloeotrichia intermedia (Lemm.) Geitler v. **kanwanensis** C. B. Rao
In Ramala lake, Chandrapur (1-11-64). In Abkari lake (7.5), Bhandara (29-12-68).

G. natans Rabenh. ex Born. et Flah.
In Gaon lake (7.2), Sakoli (5-1-69).
Cells and heterocysts are slightly broader.

G. pilgeri Schmidle
Epiphytic on aquatic plants in ponds, Umred (30-11-64), Vadali lake, Amravati (18-10-64), Mansar (13-12-64), Nave lake (9.5), Bhandara (19-1-69).

G. raciborskii Wolosz.
Planktonic in Gaon lake (7.2), Sakoli (5-1-69).

G. raciborskii Wolosz. v. **kashiense** C. B. Rao
In Vadali lake, Amravati (18-10-64).

Hapalosiphon baronii West et West
In a pond, Mansar (13-12-64).

H. hibernicus West et West
In a pond, Mansar (13-12-64).

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A Catalogue of the Birds in the Collection of the Bombay Natural History Society—18

(Eurylaimidae, Pittidae, Alaudidae)

HUMAYUN ABDULALI

[*Continued from Vol. 72*(1): 131]

843 specimens of 81 species and subspecies, up to No. 909 in INDIAN HANDBOOK and registered No. 23957 are covered by this part.

EL **Cymbirhynchus macrorhynchos siamensis** de Schauensee & Ripley (Pran, south-west Siam) Black-and-Red Broadbill

1 o? *Tenasserim Town, Burma.* Wing 97; bill 23; tail 77

The subspecific identification of this and the next is based on the distribution in Peters's CHECK-LIST, Vol. 7, p. 7.

EL **Cymbirhynchus macrorhynchos malaccensis** Salvadori (Malacca)

1 o? *Malacca.* Wing 96; bill 24.5; tail 86

The subspecific identification is as mentioned under the last.

864 **Serilophus lunatus rubropygius** (Hodgson) (Nepal) Nepal Collared Broadbill **3**:470

11 : 4♂♂ (1 juv.) 6♀♀ 1 o? juv.

1 Rajhatkhawa, Jalpaiguri dt., W. Bengal; 2 Margherita, 1 Dening, Lohit Valley, 1 Roopchena, 1 Hungum, N. Cachar, Assam; 2 *Melok R., below Wamakan* 500 *ft;* 1 *Rasa,* 1*Mansum, Chindwin Exp., Burma;* 1 no data **(ECSB)**.

	Wing	Bill	Tarsus	Tail
3 ♂♂	82,84,85	13,14(2)	18(2),19	62,64,66
6 ♀♀	81-83 av.82	14-15	17-19	62-67 av. 64
(IH ♂♀	83-88	from skull 15-17	*c.*21	66-71)

Specimen No. 9834 marked ♂ shows white-tipped feathers on either side of the neck. The two juveniles (?) lack these spots as also the grey sheen on the lower plumage. There is a slight wash of rufous on the upperparts, but I cannot see 'the rufous of the rump extending further on to mantle' as stated by Ticehurst (*JBNHS 39*:559).

865 **Psarisomus dalhousiae dalhousiae** (Jameson) (Northern India, probably near Simla) Longtailed Broadbill **3** : 472

14 : 5♂♂ 8♀♀ 1 o?

1 Longview T.E., 1 Darjeeling, 1* Kurseong, W. Bengal, 1 Berrik, 2 Singtam, Teesta Valley, 1 Martam, Rongni Valley, 1 Rinchinpong, Sikkim; 1 Margherita, Assam; 1* *Dalu,* 1* *Tawmaw,* 1* *Nanyaseik,* 1* *Mansum, Chindwin Exp., Burma,* 1* no data.

These birds can be divided into two groups, eight with underparts greenish, and six (2♂♂ 4♀♀) bluish. They show no differences in size, but the latter* (12 January to 31 March) are from Kurseong (1), and Chindwin (4), while the green (western ?) birds are dated between 26 November and 26 January. The eastern birds show slight traces (as do the others) of the character on which Hume separated *assimilis* from Thayetmyo, Burma, i.e. a small patch of blue on the nape *after* the black. This is usually concealed by the black feathers and its visibility is largely dependent on the make-up of the skin.

The specimens measure:

	Wing	Bill	Tarsus	Tail
♂♂	99-102 av. 100	17-19	27-29	120(2),125,127
♀♀	99-103 av. 101	18-19	26-28	110-130 av. 119
(♂♀	99-107	17-18	27-28	95-136)

The material available shows no difference in wing length between the sexes as suggested in IND. HANDBOOK (*4*:250) where there is no mention of the number measured.

866 **Pitta nipalensis nipalensis** (Hodgson) (Nepal) Bluenaped Pitta **3** : 444

14 : 8♂♂ (1 by pl.) 6♀♀ (2 by pl.)

1 Darjeeling, W. Bengal; 1 Sikkim; 2 Margherita, 1 Tezu, Lohit Valley, 1 Gusyong, 1 Heogagul, 1 Cachar, Assam; 2 *Dalu*, 1 *Hpala, Chindwin;* 1 *Man, Yasu Valley, Pakokku;* 1 *Aka, Chin Hills, Burma,* 1 no data.

In series, the females have paler underparts than the males, which also vary among themselves. Three males obtained by the Chindwin Expedition show dark centres to the scapulars and are slightly smaller than the others, including an unsexed bird in male plumage (No. 9075) from Man, Yasu Valley, Pakokku, Burma, further south.

	Wing	Bill	Tarsus	Tail
♂♂	115-124 av. 120	26-28	52-53	50-58 av. 53·8
Chindwin				
♂♂	115,118,119	26(2),27	50,51,52	49,50,55
♀♀	118-122 av. 120	26-28	51-56 av. 53·6	50-60 av.52·5
(♂♀	116-129	22-26	51-59	61-68)

867 **Pitta brachyura brachyura** (Linnaeus) (Ceylon) Indian Pitta

28 : 7♂♂ 10♀♀ 11 o?

1* Kalka, 1* Simla Hills; 2† Bombay, 2 Khandala, 1 Ratnagiri, 1* Wamanpalli, Chanda, Maharashtra; 1 Alanki, 2* Karwar, N. Kanara, 1† Tekkadi, 1† Peermade, Periyar, 2† Shembaganur, 2† Kodaikanal, Palnis, 2 Travancore, Kerala; 1 Anuradhapur, Ceylon; 1† Pt. Calimere, 1 Kurumbapatti, Salem, Tamil Nadu; 1† Vizagapatnam Dt., A.P., 1* Baghowni, Tirhut, Bihar; 1* Kumaon, Naini Tal, 1* Sikkim, 2 no data.

Many years ago I had noticed some colour differences in the Pittas available in the Bombay collection and though additional material and opinions were obtained, it was not possible to take any definite decision. The present re-examination reveals the same differences, and while

unable to offer any definite results, I am placing them on record for somebody else to follow up as and when opportunity offers.

They fall into 3 separate groups, all of which include specimens with dark streaks on the back:

(a) 7*: 1♂ 4♀♀ 2 o?

These differ from both the other groups in having pale underparts, greyer and less brown lateral crown streaks, and bluish green backs. They share a shiny, pale blue rump with (c).

They include all the Himalayan specimens, the southernmost being from Karwar (July) and Chanda (27 May) and were all taken between 20th May (Sikkim) and 16th October (Kumaon).

After the migrations and breeding seasons are determined, Koelz's name *pulchra* (Bhadwar, Kangra, Punjab) may be applicable to the northern population.

(b) 9†: 1♂ 4♀♀ 4 o?

These share the darker underparts etc. with (c) but are separable from both (a) and (c) by the *darker* blue of the rump.

The northernmost are from Bombay and Vizagapatnam dist. (both Oct.) and there appears to be a concentration in the south-western hills. During my earlier examination in 1955, a bird borrowed from Ceylon was also included in this group, as is suggested by its capture, presumably on migration at Pt. Calimere. This and six of the others were taken in October, with one each in January and March.

(c) 12 (unmarked): 5♂♂ 2♀♀ 5 o?

Resemble group (a) in the pale blue of the rump, but otherwise similar to (b).

The distribution overlaps that of group (b) including Ceylon, now accepted as the type locality of nominate *brachyura*. Specimens were taken in January, February (2), April (2), May, July and October (2).

The southernmost breeding record is from near Bombay, while they are known to nest regularly in Dhulia, West Khandesh and near Mhow in Central India, south and north of the Satpura Range, in June and July. No breeding specimens are available to permit any attempt at localising the separate (?) groups.

The sexes show no differences in size nor do those with the colour differences.

	Wing	Bill	Tarsus	Tail
♂♂	102-107 av 105	21-23	35-38	30-37 av. 34
♀♀	101-109 av.105	20-22	35-38	30-37 av. 34
(IH ♂♀	101-111	from skull 22-26	35-39	36-40)

868 **Pitta moluccensis megarhyncha** Schlegel (Banka) Larger Blue-winged Pitta **3** : 452

IND. HANDBOOK (*4*:254) refers to a single record from Barisal, E. Pakistan (now Bangladesh) but in the same year (1970) Paynter, *Bull.*

B.O.C. 90:118) said it was conspicuous in the Sunderbans in April, had enlarged gonads, and was probably breeding.

EL **Pitta moluccensis moluccensis** P.S.L. Müller (Tenasserim) Lesser Bluewinged Pitta **3 : 450**

3 o?

1 *Myingyan, Upper Burma* (24 May 1902), 1 *S. Irawaddy,* 1 *Copah, Malay Peninsula* (6 Oct. 1880).

Wing 119, 120, 123 (118-127): bill —, 22, 25·5 (24-26 *contra* 29-34 in *megarhyncha*); tarsus 39(2), 40 (20-24); tail 36, 39, 41 (42-45).

The measurements of the tarsus in FAUNA are no doubt in error, but accepting those of the culmen, these birds would both be of the nominate race. They show very little red on the lower belly and undertail coverts cf. Pl. xiii in the BIRDS OF BURMA (Smythies, 1953).

869 **Pitta sordida cucullata** Hartlaub (Malacca) Hooded or Greenbreasted Pitta **3 : 455**

1 ♂ Simla, NW. Himalayas.

Measurements under 870.

870 **Pitta sordida abbotti** Richmond (Nicobars) Nicobar Hooded or Greenbreasted Pitta **3 : 457**

3 : 2 ♂♂ 1 ♀ Campbell Bay, Great Nicobar

	Wing	Bill	Tarsus	Tail
1 ♂ *cucullata*	115 (109-119)	23·5 (20-22)	37 (38-42)	37 (39-42)
2 ♂♂ *abbotti*	108, 110	22·5, 23	40,40	32, 35
1 ♀ *abbotti*	109	22	37	34
(♂ ♀	103-110	22	40	39)

These birds have the green upperparts suffused with olive *contra* clear green in No. 869. The head is darker, the white patch on the primaries smaller, and compared with the single specimen of *cucullata*, the blue on the belly more prominent.

EL **Pitta gurneyi** Hume (South Tenasserim) Gurney's Pitta **3 : 457**

1 ♀ *Bankachon, S. Tenasserim*

Wing 98 (97-102); bill 22 (20-22); tarsus 39 (40-42); tail 43 (46-54).

EL **Pitta caerulea caerulea** Raffles (Sumatra) Giant Pitta **3 : 447**

1 ♂ (by plumage) *Bankachon, S. Tenasserim*

Wing 153 (138-155); bill 34 (32-35); tarsus 58 (54-59); tail 51 (61-67).

871 **Pitta cyanea cyanea** Blyth (Arakan) Blue Pitta **3 : 448**

1 ♂ *Lower Thoungyin Forest, Burma-Siamese Border.*

Wing 116 (106-116); bill 23 (22-24); tarsus 42 (43-45); tail 56 (57-62).

872 **Mirafra javanica cantillans** Blyth (Bengal) Singing Bush Lark **3 : 334**

4 : 2 ♂♂ 1 ♀ 1 o?

1 Bhimasar, Nakhtrana dist., Kutch; 1 Nadiad Town environs, Gujarat; 1 Dodi, Malwa Plateau, *c.* 1700 ft, Bhopal State, C.I.; 1 Cawnpore (cage bird).

The males (4 Sept. and 9 Dec.) from Kutch (with developed gonads) and Gujarat and the cage bird from Cawnpore are paler and less distinctly marked than the female, both above and on the breast.

873 **Mirafra assamica assamica** Horsfield (Assam) Bengal Bush Lark **3** : 336

6 : 4♂♂ 1♀ 1o?

2 Jagadhri, Ambala, Punjab; 1 Baghowni, Tirhut; 1 Rajputee Saran, Bihar; 2 Kaziranga, Assam.

The grey upperparts, and the markings on the head are quite distinct from those in *M. assamica affinis*. The birds from the Punjab are paler and less richly coloured than the others.

Measurements under No. 874a.

874 **Mirafra assamica affinis** Blyth (Southern part of the peninsula of India) Madras Bush Lark **3** : 339

23 : 12♂♂ (1 juv.) 8♀♀ 3o?

(a) 1 Kalai, Trichinopoly, 2 Pt. Calimere, 2 Chitteri Range, 1 Kurumbapatti, 2 Harur, Tirthamalai, Salem District, Tamil Nadu; 3 Palkonda Hills, 1 Seshachalam Hills, 2 Koduru, Cudappah, 1 Kavur Taluka, Nellore District, A.P.; 1 Golapalli, Bastar.

(b) 2 Baramba, 1 Talchar, 2 Barkul, Chilka Lake, Orissa, 1 Nilgiri.

The birds in group (b) (except those collected in 1902 and badly foxed) have dark upperparts, with little or no trace of rufous. They are quite different from the dark grey of nominate *assamica* but resemble them in their noticeably heavy bills, and represent an intermediate population between *affinis* and *assamica,* closer to the former.

Birds from further south show more rufous on the upperparts, a character which is more pronounced in ♀ No. 9187 from Trichinopoly. Jerdon also said that specimens from the Carnatic have a redder tinge than others from Midnapore and Ceylon. Specimens from the extreme south and southwest hills are under *ceylonensis* (q.v.).

Measurements under 874a.

874a **Mirafra assamica ceylonensis** Whistler (Colombo, Ceylon) Ceylon Bush Lark

9 : ♂♂

1 Wadakkancheri, 3 Malakku, Kumdukadru, Trichur, Cochin; 2 Kutiani (Kutyani), 1 Thattakad, Kerala, 1 Cassimode, south(?) Travancore (J.P. Cook), 1 Aramboli, Cape Comorin.

I have already referred (in press) to the validity of this large-billed race, with and without rufous underparts, occurring in Ceylon and in a very restricted area in southernmost India.

		Wing	Bill	Tail
assamica	♂♂	82,84,85 (2)	13·5-14·7 av.13·8	45,46(2), 47
	♀	81	13·6	43
	(♂♀	82-84	*c.* 13-14	45-50)
affinis	(a) ♂♂	83-87 av. 84·6	12·2-13·5 av. 13	44-48 av. 45·8

		Wing	Bill	Tail
	(b) ♂♂	78-85 av. 82	12·5-14 av. 13	41-46 av. 44·3
	(IH	77-88	from skull 15-18	42-52)
affinis	(a) ♀♀	—	—	—
	(b) ♀♀	75-82 av. 78·7	12·5-15 av. 13	39-44 av. 41
	(IH	75-82	13-17	39-45)
ceylonensis	♂♂	81-88 av. 84	13·1-14·7 av. 14	42-48 av. 45
microptera	♂	76	13	43
	(♂♀	67-77	12-13	40-45)

EL **Mirafra assamica microptera** Hume (Thayetmyo) Burmese Bush Lark **3** : 340

1 ♂ *Paukkaung, Prome District, Burma.*

The single specimen is small but washed rufous above, resembling *affinis* from around Madras and agreeing with Hume's original description of *microptera, contra* three others from Mandalay (U.S. Nat. Mus. Nos. 44982/4) which are also small but greyer above and purer white below.

Measurements under 874a.

875/6 **Mirafra erythroptera sindiana** Ticehurst (Karachi, Sind) Sind Redwinged Bush Lark **3** : 342

16 : 14 ♂♂ 2 ♀♀ (1 juv.)

4 Ambala, 1 Chandigarh, Punjab; 3 Delhi; 2 Bulandshar, 3 Meerut, 3 Cawnpore, U.P.

Koelz's *furva* from Sihor, Kathiawar, is synonymised with *sindiana* in IND. HANDBOOK (*5*:7) but the lack of topotypes of both races only permits a recording that specimens from the Punjab and Delhi have wider pale margins to the feathers of the back, and are in series paler than those from further south. Those from Uttar Pradesh are old and badly prepared and are perhaps best left together.

The others which are placed under nominate *erythroptera* show differences of colour, but are in series darker.

No. 18228 from Ambala, marked "juvenile" is darker above. A juvenile from Cawnpore (No. 9152) has the head streaks broken into spots, and the rufous on the primaries extends much further towards the tips, than in adults.

The measurements are under 877.

877 **Mirafra erythroptera erythroptera** Blyth (Northern Deccan) Redwinged Bush Lark **3** : 341

21 : 17 ♂♂ 2 ♀♀ 2 o?

2 Bhuj, 2 Kharirohar, 1 Chadva, 1 Kutch; 2 Vaghjipur, 1 Deesa, Palanpur, 1 Dalkhania, Amreli, Gujarat; 2 Narwer Fort, 1 Bhind, 1 Bhadarwar, Gwalior, 1 Dodi, Malwa Plateau, 1 Sanchi, Bhopal; 1 Jabalpur; 1 Poona, 1 Kannad, Aurangabad, 2 Mukher, Nanded District, Maharashtra.

		Wing	Bill	Tarsus	Tail
sindiana	♂♂	72-83 av. 80	12-13	21-24	45-53 av. 50·5
	1 ♀	70	–	20	44
	(IH ♂♀	73-84	from skull 13-15	21-23	46-56)
erythroptera	♂♂	75-82 av. 80	12-14	21-24	46-53 av. 50
	(IH ♂♀	75-84	from skull 13-15	21-23	47-55)

In *sindiana* the birds from Delhi and westwards have their wings average 81 mm *contra* 77·5 in the eastern birds.

The preponderance of males in both groups is noticeable and inexplicable.

As already indicated under 875, these birds show differences in colour. The southernmost is from Poona and it is unfortunate that the only specimens available from Point Calimere in Tamil Nadu where several *erythroptera* are said to have been handled by the Ringing Camps (*JBNHS 68*:458) are *M. assamica*.

EL **Lullula arborea pallida** Zarudny (Hills of Transcaspia) Wood Lark

1 ♂: *Amara, Iraq.*

Wing 100; bill 12·7; tail 52.

The subspecific identification is based on the locality.

878 **Eremopterix grisea** (Scopoli) (Gingee, S. Arcot) Ashycrowned or Blackbellied Finch Lark **3**:353

67 : 43 ♂♂ (2 pull., 2 juv.) 19 ♀♀ 5 o?

1 Rawalpindi; 1 Thanessa, Karnal District; 1 Bhong, Indus River, 1 Bahawalpur, Punjab; 6 Delhi; 2 Meerut; 2 Bhinmal, 1 Pali, Jodhpur; 3 Jaithari, Bhopal; 1 Chadva, Bhuj, Kutch; 1 Radhanpur, 2 Patan, Mehsana district, 1 Pariaji, Kaira district, Gujarat; 1 Deolali, 1 Nasik, 1 Shil, Thana; 7 Santa Cruz, 1 Pali Hill, Bandra, 1 Bombay, 3 Panchgani, 2 Satara; 1 Bargi, 1 Karwar, 1 Shirgunji, S. Kunta, 1 Kanara; 1 Talewadi, Belgaum; 1 Wadakkancheri, 1 Trivandrum, 1 Trichinopoly, 1 S. Arcot, 1 Madras; 7 Cumbum Valley; 1 Koduru, S. Cuddapah; 4 Godavery Delta; 1 Nayagar State, Orissa; 2 Purulia, Manbhum, 1 Madhubani, 1 Baghowni, Tirhut, Bihar.

IND. HANDBOOK accepts no subspecies from over the wide range of this species, but the specimens/series from different areas show differences, which if supported by additional material would probably justify separation. Among the males, birds from Satara, Karwar and Kerala, are darkest above, while others from Bhong, Bahawalpur, Bhopal and Delhi, are the palest, several of the latter being marked *siccata* by Whistler. A single bird from Talewadi, Belgaum, has the upperparts brown and the upper surface washed with rufous, a character on which other subspecies have been described from the same area. When at the Yala Sanctuary in Ceylon (July 1967), I noted that they "appeared different from Indian birds".

The females show other differences. The two from Delhi are outstandingly palest.

	Wing	Bill	Tarsus	Tail
♂♂	73-79 av.75	10-11	16-18	37-45 av. 41·5
(IH	74-80	from skull 11-13	15-17	37-44)
♀♀	72-76 av. 74.5	10-11	15-18	36-42 av. 39·5
(IH	72-79	11-13	15-17	37-44)

879 **Eremopterix nigriceps affinis** (Blyth) (Karachi) Black-crowned Finch Lark **3**: 355

9 : 6♂♂ 3♀♀

4 Karachi, 1 10 m off Karachi (?); 3 Phalodi, Jodhpur State; 1 Kuar Bet, Kutch.

The two males and two females from Karachi, all collected by C.B. Ticehurst in 1918 have their upperparts paler than in the others. Shivrajkumar (*JBNHS 66*:625) refers to flocks and individuals seen in different parts of Gujarat and suggests migratory movements.

	Wing	Bill	Tarsus	Tail
♂♂	79-85 av. 81.5	10-11	17-19	48-52 av. 50
♀♀	74,75,78	10(3)	17,17,18	45,47(2)
(IH	♂♀ 78-83	from skull *c*.12	16-17	46-51)

EL **Ammomanes dunni eremodites** Meinertzhagen (Sheikh Othman, Aden Protectorate, Arabia)

4 : 2♀♀ 2 o? *Siyahad, Arabia* (St. John Philby, March 1940).

Wing 83, 88, 95(2); bill 12·5, 13·2, 13·5(2); tail 49, 51, 53 56.

No. 9394, wing 95, was identified at the Smithsonian Institution by Mr. Bond, who informs me that accepting Siyahad as at 25°38′N., 47°05′E., these records extend the accepted range of the species into eastern Arabia.

Ammomanes deserti

Most of the extra-limital part of the collection has been gone over by Ticehurst (?) and trinominally named, but it is not possible to link the identifications with any paper nor to confirm the groupings, particularly of *iranicus* and *phoenicuroides,* and I am not disturbing the identifications (except for three specimens of *orientalis* from Meshed, North Persia) and am only referring to the differences.

EL **Ammomanes deserti cheesmani** Meinertzhagen (Shatt-el-Adhain, Iraq) Desert Finch Lark

2 o? *Shatt-el-Adhain, Iraq.*

The two topotypes can be picked out from the others from Samara not very far away by the greater amount of pink on the upperparts.

Wing 96, 99; bill 12(2); tarsus 21, 22; tail 65, 66.

EL **Ammomanes deserti isabellinus** (Temminck) (Deserts of Aquaba, Arabia)

4 : 1♂ 1♀ 2 o?

2 *Bait-al-Khalif,* 1 *Samara, Iraq;* 1 mile 30, 1200′ *Kal Kerim*(?), *Persian Gulf* (C.E. Capito 14-1-25).

These are similar to *cheesmani* but less pink above. They are marked *fraterculus* ? which is synonymised with *isabellinus*, in Peters's CHECK-LIST.

Wing 94, 96, 100, 101; bill 12(2), 13,-; tarsus 20, 22, 23,-; tail 63, 64, 68(2).

EL **Ammomanes deserti iranicus** Zarudny (Hurmuck, Persian Baluchistan)

6 : 4♂♂ 2♀♀

2 *Amirabad*, 2 *Kalat Yussuf*, 1 *Birjand;* 1 *Tigat* 4000′, *eastern Persia.*

These birds are in series browner and less grey than those marked *phoenicuroides.*

All were collected by LaPersonne in December 1926 (2), January (1) and March 1927 (3).

	Wing	Bill	Tarsus	Tail
♂♂	106,109 (3)	12-13·2	23-24	70,72,73,-
♀♀	101,102	12·5,13·5	22,23	68 (2)

Meinertzhagen (*Ibis* 1920: 143) identified birds from Quetta as of this subspecies.

EL **Ammomanes deserti orientalis** Zarudny and Loudon ("lower mountains of southwestern Bukhara...... Kushka River, sporadic in northwestern corner of Persia; around the middle Amu Darya..).

3 : 2♂♂ 1♀ *Meshed, North Iran.*

The birds collected by LaPersonne in February 1927 are slightly paler and sandier than *iranicus* and larger than *isabellinus* and may well be *orientalis* as indicated by Vaurie in BIRDS OF PAL. FAUNA p. 24. Paludan 1959, ON THE BIRDS OF AFGHANISTAN p. 141 refers to those from North Afghanistan as *orientalis* but says they are even paler than *cheesmani* from Salehabad and Kulmabad (?) in S.W. Iran. The topotypes of *cheesmani* available for comparison (*supra*) are however distinctly paler.

	Wing	Bill	Tarsus	Tail
♂♂	104,108	12,12	23,25	71,72
♀	103	10·5	24	68

880 **Ammomanes deserti phoenicuroides** (Blyth) (Kashmir) Indian Desert Finch Lark **3** : 352

23 : 11♂♂ 9♀♀ 3 o?

1 *Gudar-i-Ghichi*, 3000′, 2 *Aliabad*, 1 2000′ *Bandan;* 1 *Bali Komh*, 2 *Kunik*, 3500′ *Seistan & Kain;* 3 *Kaidasht Pass*, 7000′, *Kain*, 1 *Ab-i-Kahugan*, 44 *m. s.e. of Khawash*, 4700′ *Persian Baluchistan;* 1 *Lokh*, 100 m. south of *Kalat*, 1 *Korak* (*Pelar*), (180 *m. s. by w. of*) *Kalat, Baluchistan;* 1 Malkand, 1 Risalpur, N.W.F.P.; 2 Taxila, 1 Campbellpur, Punjab, 2 Manthar, Cholistan, 2 Bahawalpur Town environs, Bahawalpur.

Individuals from scattered areas, show differences in size and colour. According to Vaurie the birds from Seistan and Persian Baluchistan should be *iranicus* but they are marked *phoenicuroides* by Ticehurst and agree better with them. ♂ No. 9374 from Gudar-i-Ghaichi; Bandan,

in Seistan, is dark above and shows a heavier bill than most of the others. Another ♂ No. 9373 Korak (Paler) 180 m. south by west of Kalat in Baluchistan resembles *orientalis* in colour but has a small 94 mm wing.

Among the others, two from Manthar, Cholistan, Bahawalpur, collected by Sálim Ali on 21 and 25 February 1939 are very pale above and approach *isabellinus/cheesmani,* except that they lack the pinkish tinge and have less rufous on the upper tail-coverts. Another (No. 9388) from the same place (27 February) is darker, while two more from Bahawalpur Town environs may well be included in the range of variation in others under *phoenicuroides.* Whistler (*JBNHS 42*:731) makes no reference to these differences, but in the course of the report Sálim Ali draws attention to the fact that Manthar falls into a part of the Great Indian Desert known as Rohi Cholistan, a distinct biotope separated from Bahawalpur town "by a depression known as the Hakra, the ancient bed of a bygone river'. Two more specimens obtained here are not now available, but there appears little doubt that an examination of these differences, particularly in the field, would be of interest.

881 **Ammomanes cincturus** Zarudny and Hartert (Mujnabad, eastern Iran) Blacktailed Finch Lark **3**:351

3 : 1♂ 2♀♀ *Duzdap,* 5000', *Seistan, Iran* (October 1926)

	Wing	Bill	Tarsus	Tail
♂	99	10	23	56
♀♀	94,94	–,10	21,22	53,55
(♂♀	97-102 Hartert, 92,93 FAUNA)			

In IND. HANDBOOK (*5*:13) this is referred to as a race of *phoenicurus,* but they appear to be very different and are perhaps better placed in a separate species as in Peters's CHECKLIST.

882 **Ammomanes phoenicurus phoenicurus** (Franklin) (Between Calcutta and Benares) Indian Rufoustailed Finch Lark **3**:350

36 : 22♂♂ 11♀♀ 3 o?

2 Bhuj, Kutch; 1 Sanchi, Bhopal; 1 Kuno, Gwalior; 1 Harisal, Berar; 1 Bodeli, Baroda, 1 Dohad, Gujarat; 2 Sinnar, Nasik, 4 Bassein, Thana, 2 Dharamtar Creek, 1 Nagotna, Kolaba, 2 Panchgani, 1 Satara, 3 Ratnagiri; 6 Cumbum Valley; 3 Jabalpore, 1 Saugar, 1 Gondia, 1 Bhanupratapur, Kankar; 2* Orissa (* No. 18375 missing).

The material available shows differences of colour and the birds along the western side from Kutch southwards to Kolaba District appear slightly darker both above and below. The chins in the eastern birds appear distinctly paler. Two from Vengurla (the third is an old and dilapidated skin) maintain the darkness and differ in having the scapulars washed and tipped with rufous, a character absent in all the others.

In the absence of any birds from south of the Cumbum Valley, it is not possible to comment upon the validity of the next form *testaceus.*

♀ No. 9355 from Harisal, Berar, dull brown all over, paler on the underparts and with almost no markings on the breast, is presumably a juvenile. The outer webs of all the primaries are bright rufous, distinguishing this from the others.

	Wing	Bill	Tarsus	Tail
♂♂	99-106, one 111, av. 104·5	12·5-15 av. 13·5	22-24	58-65 av. 61
	(IH 100-110	from skull 15-17	21-24	57-64)
♀♀	93-105 av. 99	12·5-14·5	22-24	53-60 av. 57·6
	(IH 98-104	from skull 15-16	21-23	52-63)

883 **Ammomanes phoenicurus testaceus** Koelz (Salem, Madras) Southern Rufoustailed Finch Lark

nil.

884 **Alaemon alaudipes doriae** (Salvadori) (Iran) Large Desert Lark **3**: 304

15 : 6♂♂ 7♀♀ (1 juv., 2 imm.) 2 o?

3 *Shaiba, Iraq;* 3 *Lab-i-Baring, Hamunk,* 1 *Khwaja Ahmed, Seistan, Iran;* 4 Karachi; 1 Khorda, Pachaw, 1 Kharirohar, 1 Nir, Great Rann, Kutch; 1 Yazman, Bahawalpur.

According to Peters (1960, *9*:39) and Vaurie (1959), all these should be of the same race but two of the three from Iraq are paler above and have a pale rufous wash which immediately separates them from the others. They also differ in the irregularity and almost complete absence of the dark bar across the white of the secondaries, a character shared with the third from the same place, which is very worn and does not exhibit the rufous.

The juvenile from Karachi has no spots on the breast and very pale upperparts which are not barred with blackish brown as required in both the FAUNA and IND. HANDBOOK. The two immature females (Nos. 8882 and 8887) are less heavily spotted on the breast than the adults.

♂ No. 8881 from Khwaja Ahmed has the largest (137 mm) wing but is not larger than Iraqi or Indian birds in other respects, and they are all measured together.

	Wing	Bill	Tarsus	Tail
♂♂	131-137 av.133	27·5-30	36	89-98 av. 94·5
	(IH 126-137	from skull 30-35	34-37	79-99)
♀♀	115,118,120,125	24·5,25,26,28·5	31,32 (2),33	78,89,90,92
	(IH 116-119	from skull *c.* 27	30-32	*c.* 75)

EL **Calandrella cinerea brachydactyla** (Leisler) (Montpellier, France) Short-toed Lark

1 o? : 1800′ *Siyahad, Arabia* (St. John Philby, 17 March 1940)

Wing 97; bill 12, tail 60.

The specimen No. 9397 was identified by Mr. Bond.

The white outer tail feathers, the smaller bill and the brown rather than rufous upperparts immediately separate this from *Ammomanes* with which it lay unnamed for many years.

The original label is marked "in flock of 20/30".

EL **Calandrella cinerea hermonensis** Tristram (Mt. Hermon, Lebanon) Short-toed Lark

1 o? *Shatt-el-Adhain, R. Tigris, Mesopotamia.*

No. 9067 collected by C. R. Pitman on 16 October 1917 and marked *brachydactyla* has the upperparts more rufous than in any other and appears to be *hermonensis.*

Wing 89; bill 10; tarsus 20; tail 59.

885 **Calandrella cinerea longipennis** (Eversmann) (Sangora, Dzungaria) Yarkand Short-toed Lark **3**:325

42 : 23♂♂ 14♀♀ 5 o? (1* pull.)

1 *Mohamedabad;* 1 *Robat-i-Mahi,* 5 *Maina, near Turbat;* 1 *Kidri near Kain, Iran;* 1 Rekchak Hambar, Kolwa, Baluchistan; 4 Chitral Drosh, 4 Jagadhri, 1 Ambala; 3 Manthar, Cholistan, 1 Harunabad, 2 Yazman, 1 Chachran, 1 Bhong, Bahawalpur; 1 Bhinmal, 3 Jolar, Jodhpur; 1 Santawara, Gwalior; 1 Ratlam, C.I.; 2 Bhuj, 1 Mandvi, Kutch; 1 Patan, 1 Vagjipur, Mehsana, 1 Radhanpur, 1 Cambay City environs, 1 Deesa, Palanpur; 1* *Tso Morari, Tibet;* 1 *Tarning Bashi, Pamirs.*

The whole series shows considerable variation in colour, size and shape of bill, but those from Bahawalpur, Kutch, Gujarat, etc., have been marked *longipennis* either by Sálim Ali or Whistler, and with the material available, I am unable to suggest any amendment.

Some from Maina, near Turbat, paler above and with larger and flatter bills may be *artemesiana.*

Three from 4000′, Chitral, collected by Capt. H. S. Fulton in October 1902 have a pronounced rufous wash on the upper surface, but their bills are not as heavy as in *dukhunensis.* Another (No. 9069) from Chitral Drosh dated 2 April 1903 does not show the rufous wash. No. 9104 ♂ from Tarning Bashi, Pamirs, collected by A. Sheriff was named *C. a. acutirostris* by Whistler.

The inner secondaries reach the tip of the wing in only 14 of the 40 adults and this is not a useful species character as suggested in IND. HANDBOOK (5:19). In both *longipennis* and *dukhunensis,* the fourth primary is distinctly shorter than the first three (as per FAUNA) and this appears to be a more reliable index.

Measurements under 886.

886 **Calandrella cinerea dukhunensis** (Sykes) (Dukhun) Rufous Short-toed Lark **3**: 326

18 : 10♂♂ 6♀♀ 2 o?

2 Ghoti, Nasik, 2 Thana, 7 Salsette, 1 Poona; 1 Karupadanna, Cochin; 1 Godavery Delta; 1 Bhasandapur, Chilka Lake, Orissa; 1 Rajputtee Chupra, Bihar; 2 Calcutta Market.

There is some variation in colour but they are distinguished by (1) the heavier and darker streaking on the upperparts, each feather fringed with rufous, (2) the fulvous wash on breast and underparts being more

distinct than in *longipennis* and (3) the thicker bill.

Though both this and the last (885) are winter migrants from the north, all the northern specimens are *longipennis*, and the southern ones of this form!

♂ No. 19651 from Ghoti, Nasik, in worn plumage does not show the dark markings on the upper surface, but is identified on the basis of another obtained on the same day and place.

The specimens measure:

		Wing	Bill	Tarsus	Tail
longipennis	♂♂	86-97 av. 92·3	10-12	20-23	50,55-62 av. 58.5
		(IH 95-100	from skull 12-15	20-21	54-65)
dukhunensis	♂♂	92-103 av. 97	10-12	20-22	52-61 av. 57
		(IH 95-103	from skull 13-14	20-21	59-60)
longipennis	♀♀	84-92 av. 88	10-12	19-21	49-56 av. 49·4
		(IH 88-94	from skull 12-14	20-21	53-59)
dukhunensis	♀♀	86-99 av. 91	10-12 av. 10.5	20-21	50-56 av.53·5
		(IH 92-98	from skull 13-14	20-21	51-56)

Only three have the inner secondaries reaching the tip of the wing.

887 **Calandrella acutirostris acutirostris** Hume (Balakchi, upper Karkash Valley, north of Sughet Pass, Karakoram) Karakoram or Hume's Short-toed Lark **3** : 327

8 : 4♂♂ 4♀♀

3 Chitral; 1 Darazpur, Punjab; 3 Satanwara, 1 Surwaya, Gwalior.

In series, these have darker upperparts and less pure white on the outer webs of the two outermost tail-feathers than those under *tibetana* (888).

Measurements under 888.

888 **Calandrella acutirostris tibetana** Brooks (Tibet, beyond Sikkim) Tibet Short-toed Lark **3** : 328

9 : 5♂♂ 1♀ 3 o? (1 juv.)

1 Darazpur, Punjab; 1 Debring, 1 Kashmir; 5 *Tingri* 14,000′; 1 *Gyanka* 13,500′, *South Tibet.*

The juvenile from Tingri, South Tibet, collected by A. F. R. Wollaston on 27 June 1921, has pale whitish tips to all the feathers of the upperparts and tail, and rufous wash over the same area, most accentuated on the rump, and on the edges of the wing feathers.

		Wing	Bill	Tarsus	Tail
acutirostris	♂♂	90,91,92,94	11,12(3)	20,21,22 (2)	58,60,61,65
	(IH	89,96	–	ex Paludan)	
tibetana	♂♂	88-97 av. 91·2	11(4),12	20.21(3),22	53-65 av. 57.8
	(IH	98-100	from skull 13-15	19-22	54,58-65)
acutirostris	♀♀	85,87,89,93	11(2),12(2)	20,21,22(2)	55(2),59,61
	(IH	84-90	–	ex Paludan)	
tibetana	♀	87	10	21	58
	(IH	85-92	from skull 13-14	19-21	54-60)

888a **Calandrella rufescens persica** (Sharpe) (Niris, Iran) Persian Short-toed Lark **3** : 332

3 : 2♂♂ 1♀

2 *Lab-i-Baring, Lutak, Seistan Delta, Iran.*

	Wing	Bill	Tarsus	Tail
♂♀	96,98,94	10,11,10	20,21,21	61,61,60

EL **Calandrella rufescens seebohmi** (Sharpe) (Central Asia from Yarkund and Kashgar to Mongolia)

1 o? *Khotan,* 4400′.

Wing 88; bill 10; tarsus 21; tail 60.

The bill is noticeably smaller than in both *persica* and *heinei*

EL **Calandrella rufescens heinei** (Homeyer) (Volga region) Lesser Short-toed Lark

16 : 2♂♂ 1♀ 13 o?

10 *Shatt-al-Adhain,* 1 *Bait-al-Khalifa, Samarah,* 1 *Twin Canals,* 1 *Zubier,* 2 *Felujah,* 1 *Tigris, Mesopotamia.*

	Wing	Bill	Tarsus	Tail
2 ♂♂	95,96	10,10	20	61,62
1 ♀	94	10	20	58
13 ♂♀	91-100 av. 97	10-11	20-21	56-64 av. 60

No. 9125, 9127 and 9131 collected on 26th and 31st (2) Oct. 1917 have slightly paler upperparts and tend towards *seistanica* which are however yet paler.

889 **Calandrella raytal adamsi** (Hume) (Agore Valley, Hazara) Indus Sand Lark **3** : 331

17 : 12♂♂ 2♀♀ 3 o?

1 Jammu State; 1 Attock, 3 River Jhelum, 1 River Sutlej, 3 Ambala, 4 Bahawalpur, Punjab; 1 Karachi; 3 Delhi.

		Wing	Bill	Tarsus	Tail
adamsi	♂♂	78-88 av. 83	10-13	19-21	46-52 av. 49.5
(IH		80-89	from skull 11-13	19-20	48-56)
krishnakumarsinhji	♂♂	78,80,65	11(3)	19(2),21	46(2),53
(Vaurie	♂♀	76-85	from skull 12-13	-	42-50)
adamsi	♀♀	77,82	12(2)	19,21	43,46
(IH		77-82	from skull 11-13	19-20	46-50)
krishnakumarsinhji	♀♀	75,77,78,79	10,11,(2),12	19,20,21,-	43,44,45,46

The single specimen from Karachi (1903) is very rufous, a character not shown in others equally old.

890 **Calandrella raytal krishnakumarsinhji** Vaurie & Dharmakumarsinhji (Bhavnagar) Saurashtra Sand Lark

9 (details below)

(a) 5 : 1♂ 2♀♀ 2 o? Bhavnagar.

(b) 4 : 2♂♂ 2♀♀ 1 Kakhart, 1 Kandla, 2 Kharirohar, Kutch.

Group (b) from Kutch is intermediate between topotypes from Bhavnagar and *adamsi/raytal* but the heavier markings on the upperparts as well as on the breast are strikingly different from the paler, less

marked races and better placed with *krishnakumarsinhji.*
Measurements under 889.

891 **Calandrella raytal raytal** (Blyth) (Lucknow) Ganges Sand Lark **3** : 329

5 (details below)
(a) 2 : 1♂ 1♀
1 Bulandshar, 1 Cawnpore, U.P.
(b) 3 : 1♂ 1♀ 1 o?
1 *Kyithe, Prome Dist.;* 1 *Yebauk,* 1 *Henzada; Lower Burma.*

The two Indian specimens are in very poor condition, but the bills are flatter and do not show the thickness and curve visible in the two western subspecies.

The three from Burma, one marked "adult", have their heads spotted rather than streaked, and are slightly smaller.

	Wing	Bill	Tarsus	Tail
(a)	♂ 81, ♀ 76	12, -*	19,19	52, -
(b)	♂80, ♀73, o? 75	-, 13, 12	19,19,19	47,43,44
(♂♀	74-83	*c.*11-12	19-20	41-47)

* The female has a deformed bill, the lower mandible measuring 14 mm and projecting beyond the upper which is only 9 mm.

EL **Melanocorypha calandra calandra** (Linnaeus) (Pyranees) Calandra Lark

1♀ *Shustar, Southwest Iran* (February 1918)
Wing 120; bill 14·6; tail 60.

The specimen is smaller and the upperparts are darker without the yellow/rufous wash present in *psammochroa.* The bill is smaller than suggested by the length.

EL **Melanocorypha calandra psammochroa** Hartert (Dur-Badour, Khorasan, Iran) Calandra Lark

6 : 4♂♂ 1♀ 1 o?
1 *Hawi Plain,* 4 *Samarra,* 1 *Twin Canal, Mesopotamia.*

	Wing	Bill	Tarsus	Tail
♂♂	130,134,135,136	15,16(2),17	27 (2),29 (2)	65,67,68,69
♀	132	18	28	60

These birds though originally correctly identified were found with *M. bimaculata.* Apart from their larger size and the additional characters of more white both on the outer tail feathers and the inner secondaries, the white supercilium is shorter and less distinct than in *bimaculata.*

EL **Melanocorypha leucoptera** (Pallas) (Baraba Steppes, Siberia)

1♂ No. 8949, *Peking, China,* (cage bird) 17-1-1901.
Wing 112 (106-126, BIRDS OF U.S.S.R., Vol. 5); bill 17; tarsus 27, tail 55.

EL **Melanocorypha bimaculata bimaculata** (Menetries) (Mountains near Talysh, Transcaucasia) Bimaculated Lark.

1 *Tekkret Tigris, along Samarra-Tekret Railway, Iraq.*
Wing 124; bill 17; tarsus 27; tail 56.

892 **Melanocorypha bimaculata torquata** Blyth (Afghanistan) Eastern Calandra Lark **3**:312

19 : 12♂♂ 5 ♀♀ 2 o?
5 *Meshed,* 1 *Kidri,* 1 *Birjand, E. Persia;* 2 Chitral, N.W.F.P. 1 Campbellpur, Attock, 1 Jagadhri, 2 Ambala, 1 Danturi Karnal, Punjab; 2 Phaladi, Jodhpur; 1 Badu, Mandvi, Kutch; 2 Calcutta Market.

	Wing	Bill	Tarsus	Tail
♂♂	112-122	15-18	26-28	54-58 av. 56
♀♀	114-121	16-17	26-27	50-53 av. 51·6
(IH	116-126	from skull 17-18	26-27	50-61)

♂ No. 8942, one of several from Meshed, with a small bill and wing (112), shows a rufous wash on the upperparts and on the breast.

The 9 from eastern Persia and Jodhpur are on the underside much whiter than all the others, and are not only a tribute to the skinning of LaPersonne, then Assistant Curator of the Society, but also a striking example of the colour transformations which can be brought about in the process of skinning.

893 **Melanocorypha maxima holderi** Reichenow (Kloster Shinse, Kansu) Ladakh Longbilled Calandra Lark **3**:311
nil.

894 **Melanocorypha maxima maxima** Blyth (borders of Sikkim) Sikkim Longbilled Calandra Lark **3**:311
3 : 2♀♀ 1 o? (juv.) *Tinki Deong, South Tibet.*

	Wing	Bill	Tarsus	Tail
Adults	142,150	22,22	29,30	75,81
Juv.	141	18	30	72
♂♀	143-154	21-24	29-30	83-93

EL **Eremophila bilopha** (Temminck) (Deserts of Aqaba, Arabia) Temminck's Horned Lark

3 : 2♂♂ 1♀ *Baitul Khalifa, Samarra, left bank of R. Tigris, Mesopotamia.*
Wing ♂♂ 97, 101, ♀ 96; bill 11·7, 11·6; tail 60, 67, 61.

895 **Eremophila alpestris albigula** (Bonaparte) (Russian Alps, restricted to Hissar Mountains by Meinertzhagen, 1928, *Ibis*: 523) Pamir-Horned Lark **3**:307

35: Distinguished by the black of cheeks being linked with that on breast.
(a) 24 : 10♂♂ 14♀♀
1 *Asadabad Pass,* 4 *Kapi Kelen Pass* 6000′, 2 *Najmabad Pass,* 2 *Turbat-i-Haidari* 5000′, 1 *Turmal,* 1 *Meshed* 4500′, 1 *Sehdan,* 1 *Amirabad,* 2 *Birjand*; 2 *Mud* 4300′, 4 *Kaidasht Pass* 7000′, 2 *Tigab,* 1 *Kain, Eastern Iran.*

	Wing	Bill	Tail
7 ad. ♂♂	115-122 av. 117·5 (IH 112-119 Ludlow & Kinnear; 116-124 Paludan	12·1-14·2 av. 13·7 from skull 15–17)	72-80 av. 73·4
14 ♀♀	103-111 av. 108·3 (IH 105-109; 104-116	12·4-13·9 av. 13·2 from skull 15-16)	65-74 av. 68·8

The 7 immature females are included in the measurements. If separately measured their wings, bills and tails average 2·7 mm, 0·1 mm and 1·7 mm respectively shorter than in adults with white foreheads.

All these birds from eastern Iran are very similar and are marked *albigula* by a previous worker (Ticehurst?) though the type locality is a long way north. They are all distinguished by their short bills. Most of the males show a fawnish tinge on the upperparts, while those lacking this tinge are slightly smaller and no doubt immature. The immature females also show slight differences in the colour of the upperparts and the absence of white on the forehead is presumably a sign of immaturity. ♀ No. 8913 collected at Kaidasht, Kain, on 7th December has a yellowish forehead but this may be due to staining.

(b) 2 : 1♂ 1♀ *Elburz Mts. near Tehran, Iran.*

Wing ♂ 119, ♀ 104; bill 15·5, 12·2,; tail 69, 66.

Vaurie (1951: 490) quotes Stresemann (1929 *Jour. f. Orn. 76*:361) that *albigula* is the race in the Elburz mountains. I can see no trace of yellow in either bird, either on the forehead or on the underparts, but the single ♂ has a bill appreciably larger than in those under (a) and the white band on the forehead is also narrower. The ♀ has very indistinct white on the forehead, *contra* pure white in adult (a). It may be worth mentioning that Trott (*JBNHS 46*:695) notes both *albigula* (Feb.-March) and Gould's *penicillata* (July) from the neighbourhood of Tehran.

(c) 3 : 2♂♂ 1♀ all Gilgit

	Wing	Bill	Tail
♂♂	121(2), ♀ 109	12·7, 12·9, 12.4	71,80,66

The tucked-in necks and poor condition of the specimen makes it difficult to determine whether the black of the cheeks and breast are confluent but a white collar is suggested. The bills are also smaller than in those under (a). All three specimens show differences in colour. ♂ No. 8931 a very old skin but without date or collector's name is very pale and may be a migrant *pallida* q.v. No. 21483 ♀ (obtained by Biddulph in February 1879) has gray, and not white cheeks. They are left in this group in accordance with the fact that birds from Gilgit have been so identified.

(d) 6 : 5♂♂ 1♀ 3 Chitral 1400′; 3 Chitral Ghairat

	Wing	Bill	Tail
♂♂	117-122 av. 119·2	14·2-16·7	72-80 av. 75
♀	117	13·3	75

Three each were obtained by Fulton (July) and Perreau (Feb.),

and while the black cheek-stripe appears connected with the black on the breast in all the specimens, the bills are much longer than in *albigula* and show a tendency towards *longirostris*. They are no doubt resident in the area and do not agree with any description available to me. They were marked *diluta* by ? but are quite different from topotypes of this subspecies from Kashgar (see below).

896 **Eremophila alpestris longirostris** (Moore) ('Neighbourhood of Agra' corrected to Kulu and restricted to Rohtang Pass) Longbilled Horned Lark **3** : 309

14 : details below:

(a) 11 : 5♂♂ 4♀♀ 2 o? (juv.)

1 *Sassirla Pass,* 15000′ *Karakoram;* 3 Debring, Ladakh, 1 Rungdum Valley 12000′, 1 Doha Gugma 15000′, 1 Futi Runi 15000′, Lahul; 1 Lasar 13000′, 1 Kioto, Spiti; 2 Kashmir.

No. 20568 from Sassirla Pass, Karakoram, 15,000 ft is very pale and the bill is not as long as in the others, representing no doubt an intermediate population. Vaurie lists specimens from Debring, Ladakh, as intermediate with *elwesi*. ♂ No. 18280 from this place (the other two are juvenile) has the smallest wing and bill in the measurements below*.

(b) 3 : 2♂♂ 1♀ Deosai Plateau 13500′ Kashmir (all Sept.)

All three are in fresh plumage and have their upperparts paler and almost unmarked, making them very different from those under (a). The latter are however all in worn plumage and it is not possible to comment on the validity of *deosai* Meinertzhagen, which is now generally synonymised with *longirostris*.

		Wing	Bill	Tail
♂♂	(a)	124*-130 av. 127·6	14·8*-17·5 av. 16·3	79-84 av. 81
	(b)	127, mltg.	15·7, 16·4	77,84
	(IH	125-131	from skull 17-20	85-92)
♀♀	(a)	121,121, 123	15·7, 16·5(2)	76,79(2)
	(b)	114	15·5	72
	(IH	115-124	from skull 18-20	76-85)

In both (a) and (b) the bills (except in the single pale bird from Sassirla Pass) are very distinctly larger than in the *elwesi, argalea* and *albigula,* (excluding those from Chitral).

897 **Eremophila alpestris elwesi** (Blanford) (Kongra Lama Pass, Sikkim) Sikkim or Elwes's Horned Lark **3** : 310

5 : 2♂♂ (1* by pl. & imm.) 2♀♀ 1 o? (juv.)

1 Shushol, 1 Sasar Pass 15-16000′ Ladakh; 2 *Tso Morari, Tibet*; 1 Chunthong, Sikkim.

The adult ♂ from Sikkim has a distinct black band at the base of the bill while No. 18284* immature ♂ (by plumage) from Tso Morari shows traces of black both on the crown and the forehead suggesting that it is of this race, and I am for the moment leaving them together. Ticehurst (*JBNHS 32*:352) refers to *elwesi* extending as far west as Tso Morari.

		Wing	Bill	Tail	
♂♂		116*, 120	12·4*, 13	75*,79	*imm.
	(IH	114-123	from skull 13-15	76-89)	
♀♀		110,112	12·5,14·2	72,75	
	(IH	109-112	from skull 13-15	73-87)	

The large 14·2 mm bill of ♀ 18285 from Sasar Pass, Ladakh is an indication of the trend towards *longirostris*.

EL **Eremophila alpestris diluta** Sharpe (Central Asia, Kashgar)

3 : 3♂♂ 2 *Kashgar*, 1 *Yelpaktesh* (*Chinese Turkestan*).

These birds collected in January and June have their upperparts much paler than in others. Though synonymised with *albigula* they are very different in colour from the large series under 895 (a) above, and probably represents a valid subspecies.

Wing	Bill	Tail
120,120, -	11·9,14,14	75,76,81

EL **Eremophila alpestris argalea** (Oberholser) (Sughet Pass, Kuen Lun Mountains)

7 : 4♂♂ (1* by plumage) 2♀♀ 1 o? (pull.)

1 *Chasha*, 1 *Khamba Dzong*, 4 *Tingri*, 15000′ *Tibet*, 1* n. of *Suget Pass. Karakoram Range.*

Six of these were collected by A. F. R. Wollaston in July 1921 on the way to the first assault on Everest. Though marked *elwesi* (also Hingston *JBNHS 32*:325) the 3 adult males are immediately separable by the fine white streak (*contra* wider white band in *elwesi*) across the forehead. Though very distinctive, its range of distribution appears encircled by *elwesi*, as at present acceptesd(?).

	Wing	Bill	Tail
♂♂	117, 119(2)	12·4-13·8	70,74,81
♀♀	111(2)	11·8,12	70(2)

The pullet has a yellowish wash on the chin.

No. 8930 from north of Suget Pass was collected by Stoliczka on the Forsyth Expedition in October 1873; the feathers of the forehead having fallen off, the extent of the white band cannot be determined, but it is very pale above and shows much yellowish on the white parts, both of which may be due to the age of the specimen. It is in very poor condition and no measurements are possible.

EL **Galerida cristata cristata** Linnaeus (Vienna) Crested Lark

2♂♂ : 1 *Dinnyes, W. Hungary;* 1* *Kunfeherto, S. Hungary.*

Wing 110, 112*; bill 16·2, 17·6*; tarsus 23·5, 25*; tail 62*, 64.

Vaurie (1959) includes *tenuirostris* C. L. Brehm (Sarepta, Lower Volga) with the nominate race, but No. 23428* from S. Hungary is so marked, and has a more slender bill than the other.

EL **Galerida cristata** subsp.

4 : 2♂♂ 1♀ 1 o? 3 *Muscat*, 1 *R. Tanhat, Arabia.*

Wing 105, 106, 110, 112; bill 19·1, 19·2, 20·4; tail 62, 63, 64, 65.

These specimens are very similar to *subtaurica/magna* (*infra*) but the bills are larger in series. They were taken in March (3) and April (11th) and may be migrants. Ripley has described *thomsi* from Bebel Akhdar, Muscat, as a very dark race, but that name cannot apply here, and they also appear to be out of the accepted range of *altirostris.*

EL **Galerida cristata leautungensis** Swinhoe (Talienwan, Liautung Peninsula, Manchuria)

1 ♀ *Peking, China.* Wing 102; bill 16·3; tarsus 23; tail 58.

Sp. No. 20570 is very old and in poor condition. The bill is shorter and stouter and the upperparts slightly browner than in *magna.*

EL **Galerida cristata subtaurica** (Kollibay) (Eregli, Taurus)

10 : 6 ♂♂ 1 ♀ 3 o?

1* *Kazimain, Baghdad,* 1 *Felujah, R. Euphrates,* 1* *Nahr-Umar,* 1 *Basra dist.;* 1 *Shustar, S. Persia,* 1* *Mishan, S. W. Persia,* 1* *Hassanabad,* 1 *Meshed,* 1 *Mohmiabad, near Kain, Iran;* 1* Panjgur, Baluchistan.

Subtaurica and *magna* can both be separated from Indian birds by their longer wings and tails and heavier bills, but there is considerable variation in colour and overlap in size, and the two forms are barely distinguishable. Five of them (marked*) have however been identified as *weigoldi* (=*subtaurica*) by Meinertzhagen (?) and the others have been included only because they appear indentical. Three others marked *weigoldi* have been listed under *magna* (a) for they agree more closely with those tinged with rufous.

The upperparts are slightly darker but this character is not satisfactory for in more than one instance, one of two birds taken at the same place (and once on the same day) is *subtaurica* and the other *magna* (Basra dist., no dates and Mishan, S. W. Persia, 21st Sept.).

Subtaurica does not appear to have been recorded in Baluchistan.

	Wing	Bill	Tail
♂♂	108-112 (110·5)	17·3-19·8 (18·1)	60-65 (62·5)
♀	111	18·4	64
o?	108,112.116	18·8,19(2)	–,61,68

898 **Galerida cristata magna** Hume (Yarkand) Yarkand Crested Lark **3** : 345

53 : details below.

As indicated above, it is barely possible to separate *magna* from those under *subtaurica* and they are again divisible into three groups:

(a) 15 : 9 ♂♂ 1 ♀ 6 o? Large and rufous above.

1* *Baitul Khalifa, Samarra,* 1* *Sheik Saad,* 2 *41 m. n.e. of Kut, right bank of Tigris,* 1* *Basra dist,, Mesopotania;* 1 *Mishan, S.W. Persia,* 1 *Shustar;* 1 *nr. Meshed;* 1 *Gurid,* 1 *Kain,* 1 *Chah-i-Mirza Khan,* 1 *Lab-Baring, Seistan;* 1 *Duzdap, Iran;* 2 *Kashgar, China.*

Three* skins included here were marked *weigoldi* by Meinertzhagen (?).

♂ No. 9282 from Kashgar (Bailey, 20th June 1918) has the longest wing (118) and the bill (19) and tail (69) are also among the largest. The others all taken between 21st Sept. and 4th February may well be migrants.

(b) 28 : 12♂♂ 10♀♀ 6 o? Similar to (a) but not rufous.

1 *Felujah, R. Euphrates,* 1 *Sheik Saad, Mesopotamia;* 1 *Meshed,* 2 *Rabat-i-Mahi, Khorasan,* 3 *Turbat, nr. Meshed,* 1 *Amirabad,* 1 *Birjand;* 2 *Naugab, near Kain,* 3 *Kain,* 1 *Kidri, nr. Kain,* 2 *Afzalabad,* 3 *Duzdap,* 1 *Bunjar,* 3 *Chah-i-Mirza Khan, Seistan Delta;* 2 *Farghana-Baghdad, Uzbekistan, U.S.S.R.*; 1 Bunji, Gilgit.

The two unsexed birds from Farghana, Uzbekistan, obtained in June, have their upperparts greyer than in the others. They measure: Wing 111, 113; bill 15.7, 18.8; tail 64, 69.

(c) 10 : 8♂♂ 2♀♀

1 *Kain-i-Daud, 15 m. n.w. of Dizak, Persian Baluchistan;* 1 Chaman, 1 Quetta, 1 Kalat, Baluchistan; 1 Wana, N.W.F.P.; 3 Campbellpur, Punjab; 1 Delhi; 1 Chini, Larkana, Sind.

Nos. 9233 Persian Baluchistan (29th July) and 18348, Chaman (August) were presumably on their breeding grounds. The others from northern India, all obtained in winter, may be migrants. They differ from those under *chendoola* in their slightly larger wings and bills; in some the bills are not as stout as in *magna* and they are separated on the basis of their longer tails—an apparently consistent character of *magna* and others.

	Wing	Bill	Tail
♂♂			
(a)	106-114, one 118 (111·2)	16·3-19·5 (18·3)	62-69 (65)
(b)	104-115 (111)	16·3–20 (17·7)	62-69 (64·6)
(c)	102-107 (105·3)	16·1-17·9 (17·3)	59-64 (60·7)
(IH	109-116	from skull 20-22)	
♀♀			
(a)	102,105	17,17·2	61-62
(b)	100-112, one 117 (105·4)	16·1-17·5, one 19·1 (16·7)	57-63, one 69 (61·2)
(c)	102,103	16·3, 17·8	61-62
(IH	106-109	from skull 20-22)	

The three from Campbellpur have a narrower band of spots across the breast and the same applies to No. 18342 from the same place which I have placed under *chendoola* for its shorter tail.

No. 9237 is an exceptionally large female (Rabat-i-Mahi, Khorasan, 20th Jan. Wing 117, bill 19·1, tail 69). Is it possible that the largest birds are *magna* while all the others, including some under *subtaurica* represent an intermediate population, which is also migratory?

899 **Galerida cristata chendoola** Franklin (Between Calcutta and Benares) Indian Crested Lark **3** : 343

36 : details below:

(a) 27 : 10♂♂ (juv.) 13♀♀ 4 o? (1 juv.)

1 Jammu, Kashmir; 1 Campbellpur, 1 Lahore, 1 Murakpur, near Ambala, Punjab; 1 Bhong, 1 Harunabad, Bahawalpur; 2 Delhi; 1 Tilwara, Jhunni R., Jodhpur; 4 Meerut, 2 Kanpur, 1 Fatehpur, U.P.; 2 Bhagowni, Tirhut, 1 Rajputtee, Saran, 1 Hanowshi, Samastipur, Bihar, 1 Radhanpur, 1 Jamnagar, 1 Dwarka, Okhamandal, 1 Khari Rohar, 2 Kharaghoda, 1 Mandvi, Gujarat.

Some of the specimens from Gujarat are grey on the upperparts, approaching the colour of the nominate race and quite equal to that of the single *lynesi* available. Fresh material is required to permit the adjustments which appear necessary.

(b) 9 : 4♂♂ 3♀♀ 2o?

1* *Kalo Karim*, 1 *Shiraz*, 1 *Charbar, Iran;* 1 *Geh*, 1 *Gusht, Dizak, Persian Baluchistan;* 2 Chitral Drosh, 1 Kilia Drosh, 1 Wana, N.W.F.P.

While the small difference in size would not warrant a subspecific separation from *chendoola,* these specimens are much paler on their upperparts and it is not possible to decide if this difference is natural or due to fading. No. 9216 ♂ from Kalo Karim, Fars, obtained by Capito was recorded as *magna,* but the small 102 mm wing and 56 mm tail, together with the other similar specimens, leave little doubt that either *chendoola* or another small subspecies is resident through southern Baluchistan and Iran, as far west as Shiraz (July). As in northern India, the position is confused by larger winter migrants visiting the same areas, and the fact that the majority of specimens has been collected in the cold weather. Though unable to offer any very definite results, I have the impression that the individual variation in size is not so random as suggested by earlier workers and that sufficient material and study would fit them into more compact groups.

	Wing	Bill	Tail
(a) ♂♂	97-101 (99.2)	16.2-17·9 (17·2)	54-57 (55)
(IH	98-105	from skull 19-23	54-63)
(a) ♀♀	93-101 (96·3)	15·7-17·5 (16·7)	51-56 (54)
(IH	92-98	—	51-55)
(b) ♂♀	97-104 (101.1)	15-17-16·2)	53-58, one 61 (57)

♂ 9273 from Chitral Drosh obtained on 14th April has a 61 mm tail, but all the others have them under 60 mm including ♀ 9274 (56 mm) obtained at the same place on the same day.

Group (c) under *magna* (898) is separated by the longer tail but may perhaps represent this population. Some of the more recent skins, particularly from Gujarat have the grey of the underparts approaching that of the nominate race, and more distinctive than in the single *lynesi* available.

900 **Galerida cristata lynesi** Whistler (Gilgit) Gilgit Crested Lark

1♀ 4900′ Gilgit, Kashmere. 12th June 1928.

Wing 96; bill 16·4; tail 55.

This specimen is not distinguished from Gujarat under *chendoola* (a).

901 **Galerida malabarica** (Scopoli) Malabar Crested Lark **3** : 348

29 : 15♂♂ (1 juv.) 11♀♀ 3 o? (1* juv., 1* chick)

6 Salsette, Bombay; 1* Bhiwandi, 1 Belapur Road, 2 Murbad Road, Kalyan, Thana; 1 Panvel, 1* Kihim, 1 Nagotna, Kolaba; 1 Walwan, Poona; 1 Panchgani, Satara; 2* Rajapur, 1 Ratnagiri, 1 Bhatkal, 1 Gotegole, 1 Manki, 1 Karwar, 1 North Kanara; 2 Talewadi, Belgaum, 2 Mercara, Coorg; 1 Honametti, Mysore; 1 Kethi, 6700′, Nilgiris.

	Wing	Bill	Tail
♂♂	89-102 (96)	13·6-16 (14·8)	46-55 (51·2)
(IH	98-105	from skull 16-18	54-63)
♀♀	90-98 (93·5)	14-14·6 (14.7)	47-55 (50)
(IH	91-94	from skull 16-17	46-52)

In the present series, the northernmost birds from Bombay and surrounding areas (which are the freshest) can be distinguished from others from North Kanara and southwards by the purer white of the underparts, particularly the lower belly; but it is not possible to determine to what extent this difference is natural or due to foxing/staining. Sp. No. 23886, Bhiwandi, Thana, which had a soft skull has the breast-spots on a background which is darker than the chin and belly, and which forms a distinct patch across the breast. Similar bands are visible in other specimens and may be an indication of immaturity. The material available does not support Koelz's *propinqua* (1939) from Londa, N. Kanara which was said to have the breasts paler and less prominently marked than those from the south.

902 **Galerida deva** (Sykes) (Dukhun) Sykes's Crested Lark **3** : 347

26 : 17♂♂ (2* juv.) 7♀♀ (1* juv.) 2 o?

1 Mandvi, 1 Padhar, 2 Chaduva, Bhuj, 1 Kutch; 1 Dalkhania, 1 Amreli, 1 Kodinar, S. Kathiawar, 1 Sait, Kaira, 2 Dohad; 2* Devlali, 2 Dindori, 3 Nasik, 1 Aurangabad, 1 Khangaon, Poona; 1* Ratlam, 1 Sardarpur, Gwalior, 1 Dodi, Malwa Plateau, Bhopal, 1* Mandu, Dhar State, C.I.; 1 Cawnpore, 1 Agra (cage bird).

	Wing	Bill	Tarsus	Tail
♂♂	83-91 (85.3)	12-14	20-21	48-52 (50·6)
(IH	84-92	from skull 13-15	20-21	46-54)
♀♀	78-83 (80·8)	11-13	20-21	45-49 (47)
(IH	76-86	from skull 13-15	20-21	43-50)

Some have more rufous underparts than others but this is probably due to foxing. A few have their breasts more heavily marked.

903 **Alauda arvensis dulcivox** Brooks (Himalayas and plains of northwestern Punjab amended to Djarkent, Russian Turkestan) West Siberian Skylark **3** : 315

11 : 4♂♂ 7♀♀

1 *Sheik Saad,* 1 *Amara, Mesopotomia;* 1 *Majas, Persian Baluchistan;* 1 Wana, Waziristan; 2 Rawalpindi, 1 Karnal, 4 Ambala, Punjab.

In series, these are slightly paler and more rufous than the other skylarks, but all are old specimens and the amount of overlap makes it

impossible to separate *dulcivox, cantarella* and *intermedia*(?). They were however examined by Ticehurst and the grouping is on the basis of his identifications on the labels.

♂♂	Wing	Bill	Tail
dulcivox	115,116,118,121	12,12·6,13,13·6	65,69,70 (2)
(IH	114-120	from skull 15-16	66-76)
cantarella	115,116,122	12·9,13·5,–	66,68,72
(IH	115	from skull 15	70)
intermedia (?)	109,113,114,118	11·7,11·9,12·1,12·8	65 (3),66
pekinensis	101,109	11,11·7	60,63
nominate *arvensis*	117	13·1	69
♀♀			
dulcivox	104-112 (107·5)	11·3, 12·3 (11·9)	60-66 (63)
(IH	104-120	from skull 14-16	61-70)
cantarella	106,107,115	12,12 8 (2)	74
(IH	108	from skull 14	67)
intermedia (?)	108,109,119	11.8,12 3 (2)	64 (2),73
pekinensis	107,114	10-7,11.1	62,65
nominate *arvensis*	111,112	11.2 (2)	60 (2)

903a **Alauda arvensis cantarella** Bonaparte (Central Italy) Caucasian Skylark

14 : 3♂♂ 3♀♀ 8 o?

4 *Hawi plains, Samarra,* 1 *Sheikh Saad,* 2 *Shatt-el-Adhain,* 2 *Feluja,* 1 *Mosul* 1 *Kazimain;* 2 Bhong, Indus Riverain, Bahawalpur, Punjab, 1♀ no data.

These are slightly darker than *dulcivox,* but see remarks and measurements under 903.

♂ No. 8964 from Mosul with a 122 mm wing and heavy bill is very rufous.

EL **Alauda arvensis intermedia** (?)

7:4♂♂ 3♀♀ 1 *Gorid 7000′, Kain,* 5 *Amirabad,* 1 *Birjand, Eastern Persia.*

These specimens have their upperparts slightly paler than in *cantarella* and the breasts also appear more clearly spotted than the others. But all were obtained by LaPersonne and the differences may well be due to the high standard of his skinning to which I have referred. The subspecific name, scribbled in pencil, on the label does not bear the author's name and with the transfer of the type locality of the subspecies *intermedia* to Shanghai it is difficult to guess what subspecies was meant. It is significant that Ticehurst does not refer to *intermedia* in the *Birds of Mesopotomia* but in a subsequent note (1926, *JBNHS 31*:96) while referring to some fresh specimens he apparently synonymises *intermedia* with *dulcivox,* while Vaurie (1959:56) indicates that the name has been used by authors "other than Swinhoe, for Zaleshi's *kiborti.*" The present specimens were all obtained in December-January and one label is marked "in large flocks".

EL **Alauda arvensis arvensis** Linnaeus (Sweden) Skylark

3 : 1♂ 2♀♀ *St. Catherine's Lighthouse, U.K.*

The specimens show a rufous wash on the upperparts, more pro-

nounced than in the others, except *pekinensis* (q.v.).

Measurements under 903.

EL **Alauda arvensis pekinensis** Swinhoe (Pekin, now Peiping) Chinese Skylark

5 : 2♂♂ 2♀♀ 1 o?

4 *Peking,* 1 *Foochow, China.*

All are over 70 years old and the resemblance to nominate *arvensis* may be due to foxing. They have noticeably smaller bills.

Measurements under 903.

904 **Alauda gulgula inconspicua** Severtzov (Turkestan) Turkestan Small Skylark

2♂♂ :

1 (No. 21413) *Karahalpak Village Ferghana, Tuya-Kurgan region*; 1 (No. 8985) 10,000 ft Chitral.

The Turkestan specimen dated 13th June 1937 has small, fine streaks on the breast and the upperparts are very faintly marked. Though the latter character may be included in the variations among Indian birds, the bill and tail are noticeably larger, and I am prompted to leave northern Indian resident birds as *punjaubi* (q.v.). The second is included here for its wing and tail are larger than in *punjaubi*, and having been collected on 2nd July was no doubt resident in the neighbourhood.

Measurements under 907.

904a **Alauda gulgula punjaubi** Whistler (Ferozepur, Sutlej River) Punjab Skylark

17 : details below:

Except for a statement by an unnamed reviewer of Sálim Ali's BIRDS OF TRAVANCORE AND COCHIN (*Ibis* 1937, p. 189) I can find no authority for synonymising *punjaubi* with *inconspicua* as has been done in INDIAN HANDBOOK (*5*:44).

The *inconspicua* (No. 21213) from almost the type locality has a larger bill than any of the specimens from northern India, and the tail (61 mm) is also larger than in most. With this material, *punjaubi* appears to be distinct and I am listing them separately. The eastern birds from the United Provinces are old and faded, and though in all probability identical, I am listing them separately under the same name.

(a) Fresh western birds: 8 : 2♂♂ 4♀♀ 2?

1 Jagadhri, Ambala, 1 Karnal, 2 Daulatpur, 1 Chacharan, Bahawalpur, 1 Mandvi, Kutch; 1 Satanwara, Gwalior; 1 Sarsava, near Saharanpur, U.P.

Nos. 9056 ♂ from Mandvi, Kutch, and 9055 ♀ Gwalior are in worn plumage, with the upperparts showing a pattern different from that of the others. The former (8th March) is from the range of the newly-described *dharmakumarsinhjii* and is no doubt a migrant into the area.

(b) Eastern and faded (?): 9 : 7♂♂ 2 ♀♀

3 Meerut, 6 Kanpur, U.P.

Both groups, (a) and (b) are slightly larger than nominate *gulgula* and have the underparts white rather than buffish.

Measurements under 907.

905 **Alauda gulgula lhamarum** R. & A. Meinertzhagen (Ladak = *guttata* Brooks) Kashmir Skylark 3 : 318

9 : 4♂♂ (1 by size) 4♀♀ 1 o?

1 Srinagar, 1 Chasm Sharif, 1 Sooknas, Kishtwar, 1 Cashmir 7000′, 1 Kashmere; 1 Fagu, Keonthal State, 2 Simla Hills, 1 Darazpur, Ambala.

Distinguished from *punjaubi* by the more promient rufous on the breast which is marked with heavy spotting. The chin is also irregularly and faintly spotted, a character missing in the neighbouring subspecies, but specifically said to be absent in *lhamarum* by Dementiev *et al.* (1970 para 535). There is some variation in the colour of the upperparts and all the specimens are not identical. The birds from Simla and Darazpur were collected in November/December and bear notes suggesting that they are migrants to the area, but with the data available, there is no alternative but to leave them all together. It may be mentioned that Stuart Baker (FAUNA *8*:663) has drawn attention to the type being a carbolized specimen in immature plumage.

Measurements under 907.

906 **Alauda gulgula inopinata** Bianchi (Tibet) Tibetan Small Skylark **3** : 316

2♂♂ *Tingri, S. Tibet* (July 1921, A.F.R. Wollaston).

Breast well streaked but on white background. The wings (101 and 105) are smaller than indicated in Vaurie "averaging about 109".

Measurements under 907.

907 **Alauda gulgula gulgula** Franklin (The Ganges between Calcutta and Benares) Indian Small Skylark **3** : 319

17 : 13♂♂ 3♀♀ 1 o?

1 Jabalpore, M.P.; 1 Rajapur, Ratnagiri; 2 Karwar, N. Kanara; 8 Godavari Delta; 1 Chilka Lake, Orissa; 1 Manjhaul, Monghyr, Bihar; 2 Dibrugarh, Assam; 1 *Shurdaung, Prome, Burma.*

When describing *punjaubi* (*JBNHS 38*:767) Whistler changed the type locality of *gulgula* from between Calcutta and Benares "to the Ganges between Calcutta and Benares". As Vaurie (1951) has already pointed out, this is no improvement for in the same place he stated that *punjaubi* extended as far east as Dinapur, which is on the Ganges between Calcutta and Benares!

	Wing	Bill	Tail
♂♂			
inconspicua	97,102	13·6,14	60,61
punjaubi (a)	93,97	13·9,14	54,55
punjaubi (b)	95-100 (98)	11·8-13·8(12·8)	50-56 (54·6)
(IH	90-101	from skull 16-17)	
lhamarum (4)	96-103 (100)	12·6-13·7 (13·1)	55-62 (58·7)
(IH	98-108	from skull 13-16)	
inopinata	101,105	12·6, -	59,61
(IH	102-108	from skull 15-16	60-68)
gulgula	86-95 (90)	13·2-14·9 (14·2)	46-52 (49·6)
(IH	87-93	from skull 14-16	49-56)
australis	90,92,94,96	12·5,13·3,13·7,14·2	48,50,51,53
(IH	90-102	from skull 14-17	49-56)
dharmakumarsinhjii	91,92,93,95	12·2,15,15.4,-	47,51,52,56
♀♀			
punjaubi (a)	87-92	13-13·3	49-53
punjaubi (b)	89,99	13·6,13·6	47,53
(IH	90-101	from skull 16-17)	
lhamarum (4)	92-98 (94·5)	11·8-13 (12·4)	53-59 (55)
(IH	93-97	from skull 14-15)	
gulgula	85,85,88	13,13·1,13·6	46,48,50
(IH	82-88	from skull 13-15	49-51)
australis	84,87,95,96	12·6,14(2),14·4	46,47,50,52
(IH	82-88	from skull 13-15	49-51)

907a **Alauda gulgula dharmakumarsinhjii** Abdulali (Bhavnagar) Longclawed Skylark

7:4♂♂ 1♀ 2 o? (Type and paratypes)

1 Mandvi, Kutch, 1 Saiat, Kaira district, 5 Bhavnagar, Gujarat.

This has been separated on the basis of the long hind claw and other differences (*JBNHS 72*(2):448.

Measurements under 907.

908 **Alauda gulgula australis** Brooks (Ootacamund, Nilgiris) Nilgiri Skylark **3** : 320

9 : 5♂♂ 4♀♀

2 Avalanche, Nilgiris, 1* Wadakancheri 400′ Cochin, 1 Camp Deramalai, Panthalam Hills, 1 Santhanpara, Cardamom Hills, 1 Perumalmalai, 1 Peermade, 1 Munnar, 1* Travancore.

The two marked (*) are very similar to *gulgula* and may indicate a connection at the base of ghats, restricting *australis* to the hills.

♂ 2908 from Ratnagiri, south of Bombay, is dark above and would have been included in this subspecies were it not for two pale (and old) specimens from Karwar which have probably faded. This requires further examination.

Alauda gulgula subsp. ?

4 : details below.

(a) 2♀♀ Nos. 20206 and 20641 from Kalat, and Sultanabad, 64 m south of Kalat, Baluchistan.

Wing 92, 92; bill 12·4, 12·4; tail 52, mltg.

Both have the juvenile characters of a rufous wash all over and rounded pale-margined feathers on the head and I cannot improve upon Ticehurst who left them subspecifically undetermined.

(b) 2 o? *Mt. Victoria, 7000 ft, Pakokku Hill Tracts, Central Burma.* Wing 94, 95; bill 12·5, 13; tail 49, 51.

These birds were collected on 9th and 16th May 1906 by K. C. Macdonald, and the latter is marked as shot off nest with 3 set eggs. 'In notes on some birds recorded from Burma', Garthwaite and Ticehurst (*JBNHS 39*:558) refer to two larks by Col. Rippon on Mt. Victoria which were first named *arvensis*. This name was scratched out and changed to *japonicus* by Oates, and they thought that these specimens had served to create the erroneous records of *Anthus japonicus* and *Alauda japonicus,* and decided that they were really *A. gulgula weigoldi* Hartert (Hamkow, Hupeh, Yangtze Valley) which was found in Szechwan, S. E. Tibet and N. Yunnan, being more rusty and darker than *A. g. coelivox* (Southeastern China to Central Annam).

The skins show a lot of foxing but they are too dark to be nominate *gulgula* and the measurements, particularly of the tail, do not agree with those of any of the northern races.

909 **Alauda gulgula vernayi** Mayr (Changyinhku, Burma-Yunnan border) Yunnan Skylark

I have also examined 15 skins from Bhutan which are not yet registered, obtained in recent years by Sálim Ali. They fall into two distinct groups:

(a) 9 : 6♂♂ 1♀ 2 o? Gyitsa 10,000 ft. and Bumthang, Central Bhutan.
(b) 6 : 4♂♂ 2♀♀ Eastern Bhutan

The western birds have fewer but longer streaks on the breast and there is considerable difference in the intensity of rufous on the breast. They show very distinct pale edges to most of the feathers of the upper surface presenting a very different appearance. Their bills are also much shorter. In both, the streaks at the sides of the upper breast, have coalesced into black bloches, a character mentioned in IND. HANDBOOK for *lhamarum*. The specimens which I have grouped under *lhamarum,* mostly from Kashmir, do not show this character and I am afraid that with the descriptions available, I am unable to decide if either of them is *vernayi*.

		Wing	Bill	Tail
(a)	♂♀	96-107 av. 103	11·8-12·7 av. 12·2	59-67 av. 61·1
(b)	♂♀	102-105 av. 104	12·4-13·7 av. 13	59-64 av. 61·2

After these notes were completed, the Bhutan birds were sent to Dr. B. Biswas who has identified group (a) as *inopinata* and (b) as *vernayi*. The former differ from the two specimens from Tingri, South Tibet, named *inopinata* by me above, in having a shorter and more

conical bill, a longer but slender hind claw (6 ♂♂ 15·5-18·8 av. 17·4) and more rufous above. The last may be due to the Tingri birds being in worn plumage but the other characters appear consistent.

There appears to be little doubt that the geographic variations in this Skylark are not yet fully understood, and more material and work is necessary. The key to the species in IND. HANDBOOK (5:41) refers to the 5th primary of *arvensis* falling short of tip of wing by more than 5 mm, and by less than 5 mm in *gulgula*. In the specimens handled, all *arvensis* show a large gap between the 5th primary and tip of wing and while this is an excellent character for separating the two species, the gap in most *gulgula* is over 5 and nearer 10 mm and the latter figure would serve as a more reliable index.

(*to be continued*)

Field Guide to the Amphibians of Western India

PART 3

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(*With two plates*)

[*Continued from Vol. 60*(3): 702]

This part of the Field Guide has been long overdue but owing to other preoccupations, I was not able to compile my notes earlier. The first two sections namely Introduction and Families Caecilidae & Bufonidae as part 1, and Family Microhylidae as part 2 appeared in Vol. *60*, pp. 415-438 and 690-702, (1963) of this *Journal*. This section describes a part of the Family Ranidae. The next and concluding section will describe the remaining ranid species and the tree frogs of the Family Rhacophoridae. The assistance given by Miss S. Isaac, Research Assistant at the Society is gratefully acknowledged.

Family RANIDAE: Frogs

The family Ranidae includes the "true frogs" and is after the family Bufonidae the most widely distributed of amphibian families, occurring in all the zoogeographical regions of the world except the Australian. Though the distribution of the family extends nearly to the arctic circle, the majority of the species are tropical in distribution. Aquatic and semiterrestrial forms predominate; a few are semi-arboreal. The skin is moist and frogs require a humid environment. The species of the family can be distinguished from all other Indian amphibia, except the tree frogs of the Family Rhacophoridae, by the presence of teeth on the upper jaw and the bifid tip of the tongue. One genus of Ranidae, the *Ooeidozyga,* is an exception in having the tongue entire and not bifid. This genus has not been reported from western India. The Rhacophorid tree frogs differ from the ranid frogs in having an additional cartilagenous phalange between the penultimate phalanges of their toes (*see* fig. 13 of Pt. 1 of this series, Vol. *60*:426).

Four genera of the family Ranidae occur in western India. They can be distinguished by the following key.

KEY TO THE GENERA IN WESTERN INDIA OF THE FAMILY RANIDAE

1 Pupil horizontal or roundish-subtriangular 2
1 Pupil vertical 3
2 Vomerine teeth present (*see* fig. 9 in pt. 1, Vol. *60*, p. 423) .... *Rana*
2 Vomerine teeth absent .... *Micrixalus*
3 Skin wrinkled, toes webbed .... *Nyctibatrachus*
3 Skin smooth, toes free .... *Nannobatrachus*

Nyctibatrachus and *Nannobatrachus* are endemic to the Western Ghats. The genus *Nyctibatrachus* occurs as far north as Matheran near Bombay. *Nannobatrachus* is rare and is so far known only from the Tirunelveli Hills in Tamil Nadu.

The majority of the species of the family are of the genus *Rana*. Four subgenera of the genus *Rana* occur in western India. These can be distinguished by the following key.

Genus **Rana** Linn. 1766

KEY TO THE SUBGENERA IN WESTERN INDIA OF THE GENUS *Rana*

1 Discs of toe tips if present without groove 2
1 Discs of toe tips with a crescentic or horse-shoe shaped circum-marginal groove (*see* fig. 14 in pt. 1, Vol. *60*, p. 426) 3
2 Outer metatarsals separated by web up to base or at least in the distal half (*see* fig. 12a in Pt. 1, Vol. *60*, p. 425) .... *Rana*
2 Outer metatarsals united completely or feebly separated at the distal end (*see* fig. 12b, in Pt. 1, Vol. *60*, p. 425). Inner metatarsal tubercle enlarged usually shovel shaped or crescentic .... *Tomopterna*
3 Tongue with a long pinted papilla (*see* fig. 7b in Pt. 1, Vol. *60*, p. 423) .... *Discodeles*
3 Tongue without a papilla; outer metatarsals usually separated by web to the base .... *Hylorana*

The following species of the four subgenera have been recorded from western India.

Subgenus *Rana*
Rana (*Rana*) *hexadactyla*
Rana (*Rana*) *cyanophlyctis*
Rana (*Rana*) *tigerina*
Rana (*Rana*) *crassa*
Rana (*Rana*) *verrucosa*
Rana (*Rana*) *limnocharis*
Rana (*Rana*) *brevipalmata*
Rana (*Rana*) *malabarica*

Subgenus *Tomopterna*
Rana (*Tomopterna*) *rufescens*
Rana (*Tomopterna*) *breviceps*
Rana (*Tomopterna*) *dobsonii*

Subgenus *Discodeles*
Rana (*Discodeles*) *beddomii*
Rana (*Discodeles*) *leithii*
Rana (*Discodeles*) *semipalmata*
Rana (*Discodeles*) *leptodactyla*
Rana (*Discodeles*) *diplosticta*
Rana (*Discodeles*) *phrynoderma*

Sugenus *Hylorana*
Rana (*Hylorana*) *curtipes*
Rana (*Hylorana*) *aurantiaca*
Rana (*Hylorana*) *temporalis*

Subgenus *Rana*

Aquatic and semi-terrestrial species Many are widely distributed and occur different habitats. All commercially exploited species of

Indian amphibia belong to this subgenus. The species occurring in western India can be separated by the following key.

KEY TO THE SPECIES OF *Rana* (*Rana*) OCCURRING IN WESTERN INDIA

1 Toes completely webbed (*see* fig. 12a in pt. 1, Vol. *60*, p. 425) 2

1 Toes incompletely webbed 5

2 Skin of back with longitudinal folds (*see* fig. 4 in pt. 1, Vol. *60*, p. 422) 3

2 Skin of back smooth or with tubercles and warts 4

3 Inner metatarsal tubercle strongly compressed, crescentic (*see* fig. 12f in pt. 1, Vol. *60*, p. 425); Heels do not overlap when legs are folded at right angles to the body (*see* fig. 11b in pt. 1, Vol. *60*, p. 424) .... *crassa*

3 Inner metatarsal tubercle comparatively smaller, blunt; heels overlap when the legs are folded at right angles to the body .... *tigerina*

4 Size large; skin of back smooth, 2 rows of porous warts on flanks (*see* fig. 5 in pt. 1, Vol. *60*, p. 422); snout flat, obtusely pointed ...... *hexadactyla*

4 Size smaller up to 60 mm; skin warty; a single row of porous warts on flanks; snout rounded; inner metatarsal tubercle fingerlike ... *cyanophlyctis*

5 A distinct dorso-lateral glandular fold from above tympanum to vent (*see* fig. 2 in pt. 1, Vol. *60*, p. 422); back between the glandular folds, bright orange or yellowish red or red crimson .... *malabarica*

5 Dorso-lateral glandular fold absent; no distinctive colour pattern 6

6 Toes 3/4th webbed, 2 phalanges of 4th toe free; outer metatarsals separated by web nearly to base. Tibiotarsal articulation reaches nostril or tip of snout (*see* fig. 10, in pt. 1, Vol. *60*, p. 424) .... *verrucosa*

6 Toes 1/2 webbed, 3 phalanges of 4th toe free; outer metatarsals united in the basal half; Tibiotarsal articulation reaches nostril ...... *limnocharis*

6 Toes feebly webbed, web not reaching 2nd phalange of toes; outer metatarsals separated by web nearly to base. Tibiotarsal articulation reaches tip of snout or beyond .. .. *brevipalmata*

Rana hexadactyla Lesson 1834: Indian Pond Frog

Diagnosis. Size large. Females reach 130 mm in snout to vent length. The flattish snout with indistinct canthus rostralis, the absence of longitudinal folds on the back and the web of the toes reaching the tip of toes distinguishes it from *Rana tigerina* and *Rana crassa* of equivalent size. Tympanum distinct, equal to or slightly less than diameter of eye. First finger longer than or equal to second. Toes fully webbed. A strong dermal fringe on the outer toes. Outer metatarsals separated nearly up to base by web. Tibio-tarsal articulation reaches tympanum or eye when the leg is held along the body. A small but prominent inner metatarsal tubercle.

Skin smooth above, warty on the flanks, anal area, and throat. Pustular on thighs. Two curved series of closely arranged porous warts from behind the shoulder to the groin and from the axilla to the groin distinct during the breeding season. A U-shaped line of warts above the anus and occasionally extending up the flanks. A glandular fold from behind the eye to the shoulder.

Colour. Bright grass green or olive green above, with or without a pale yellow vertebral line from snout to vent. A black streak along the eye to the shoulder fold. Behind the thighs patterned in black and white or yellow. Ventrally and on flanks white or yellowish white. Throat occasionally stippled with brown.

The juvenile has bars or spots of dark green and black on the back. Thighs with horizontal bars of black and white which may extend up to the abdomen. The largest specimen with this distinctive coloration in the *BNHS* collection measures 52 mm from snout to vent.

Distribution. South and east India up to Calcutta, along the east coast. In the Peninsula its northern limits are not definite. McCann (1934, 1940)[1&2] records this species from Bombay. The specimens are not in the *BNHS* collections. While it is likely that the species occurs in the Bombay area, it has not been since collected in and around Bombay. There is a record from Punjab. Along the west coast, the *BNHS* collection has specimens from as far north as Goa.

Breeding. The male has external vocal sacs and acquires nuptial pads on the outer aspect of the first and second fingers at breeding time. Call unknown.

The season commences with the monsoon and perhaps even during the premonsoon showers spawning might happen as suggested by juveniles in the *BNHS* collection obtained from Palghat, Kerala from March to June. In areas which receive both the southwest and northeast monsoons, two broods occur. At Trivandrum, Kerala, Ferguson (1904)[3] records the breeding season as lasting from July to September, while I have collected gravid females in October and just metamorphosed juveniles in January from the same area. The breeding habits are not fully known. Ferguson (op. cit.) states that the eggs are laid in paddy fields. Juveniles were collected by me from decaying vegetation in a drying pond. Gravid females contain 2,000+ eggs of less than a millimetre. Bhaduri (1944)[4] describes the tadpoles collected in the environs of Calcutta as olive green above with darker blotches and whitish below, the anterior portion being transparent. Teeth rows in mouth disc five but usually two are lost. Metamorphosed young with a rudiment of the tail range from 17 to 27 mm in snout to vent length but within

[1] McCann, C. (1934): Occurrence of the Si-toed Frog (*Rana hexadactyla* Lesson) in the Bombay Presidency. *J. Bombay nat. Hist. Soc. 37*:742.

[2] ——— (1940): A reptile and amphibian miscellany. ibid. *42*:57.

[3] Ferguson, H. S. (1904): A list of Travancore batrachians. ibid. *15*:499-509.

[4] Bhaduri, J. L. (1944): Further locality records of *Rana hexadactyla* Lesson in Bengal with brief notes on its tadpoles. ibid. 44:484.

this size range specimens with completely absorbed tail have also been collected.

Habits. The preferred habitat of this frog, perhaps the most aquatic of Indian amphibia, is ponds with dense aquatic vegetation where, while resting on the surface, its colour merges with the green of the plants. I have also seen the frog resting among brown drying weeds where its colour stood out in startling contrast! The frog keeps clear of open water. The preference for vegetation is probably related to the protection it may receive from aerial and aquatic predators. A wild caught specimen contained dragonfly larvae and snails. In captivity they take insects and smaller frogs. The species is common in the ponds and weed grown streches of water along the east coast of the peninsula in Tamil Nadu. It is probably more widespread than its recorded distribution suggests and is possibly often confused with the Indian Bull Frog *Rana tigerina.* It is reported to be eaten in the Madras area(Annandale *in* Boulenger 1920)[5] and would form a part of the commercial catches from Tamil Nadu and other areas in the south.

Rana cyanophlyctis Schneider 1799: Skipper Frog

Diagnosis. Medium sized frogs. Large females rarely exceeding 60 mm in snout to vent length. Male much smaller. Distinguished from *Rana hexadactyla* by its smaller size, colour, and by the following characters: Snout rounded, first and second fingers more or less equal in length. Tibio-tarsal articulation reaches up to either between the nostril and eye or the eye or the tympanum when held against the side of the body. Toe tips swollen and rounded. A single line of porous warts on flanks, from behind the shoulder to the groin. Inner metatarsal tubercle finger-like.

Skin dorsally warty. A strong fold from behind the eye to the shoulder. An U-shaped line of warts above the anus as in *Rana hexadactyla.* Ventrally smooth.

Colour. Grey, olive, brown or blackish above with darker spots or marblings dorsally. A dark-edged white band on the back of the thighs. Ventrally white, often spotted, vermiculated or marbled with black. The black on the belly is commoner and more widespread in the larger females.

Distribution. Throughout the Indian Peninsula from the Himalayas southwards, Iran, South Arabia, Sri Lanka, Nepal and Thailand.

[5] ANNADALE, N. *In* BOULENGEN (1920): Monograph of the South Asian, Papuan, Melanasian and Australian frogs of the Genus *Rana. Rec. Indian Mus.* *20*:1-223.

Breeding. While calling the vocal sacs of the males project through slits on the floor of the mouth. The inflated sacs are bluish white in colour hence the name *cyanophlyctis* for the species. The call is distinctive and easily recognised. McCann (1932)[6] compares it to the low pitched rattle of castnets. The call, though more often heard during the rainy season, is heard at other times of the year also and I believe is the only frog call heard near permanent water throughout the year.

The eggs are laid in a frothy mass in standing water though I have collected tadpoles from a fairly large stream, these were possibly a secondary introduction. Tadpoles brown in colour with darker blotches on the tail. Mouth disc with three rows of teeth, one on the upper and two on the lower lip. Beak heavy, black. A black palatine plate inside the mouth. Tadpoles vary considerably in size. McCann's (op. cit.) largest specimen with fully developed hind limbs measured 44 mm, whereas I have collected specimens in the same developmental stage measuring 74 mm in length. Tadpoles from Arabia are larger exceeding 100 mm in length (Anderson 1895).[7] The tadpoles are larvivorous (McCann, op. cit.). Juveniles at metamorphosis measure 17 to 19 mm and resemble the adult in colour and pattern.

Habits. The commonest and most easily seen of Indian frogs, inhabiting all biotopes of the country. It prefers still waters where it can float placidly on the surface. Most ponds, rain puddles and other stretches of water usually have one or two floating on the surface and several squatting along the edges. The ability of this species to skip over the surface of the water like a ricocheting stone was first remarked upon by Emperor Babar in the 16th century. In association with this habit this frog, unlike other species, does not let the hind legs dangle but has them parallel to the surface of the water permitting the quick flurry of strokes necessary for the skipping get away. After skipping for some distance the animal may remain on the surface, or make a short dive and return to the surface or dive and scramble into the mud at the bottom depending on the extent of its alarm. The distance covered in the skipping alarm flight depends on whether the frog had taken off from land or water. The skipper is both diurnal and nocturnal and during the rainy season wanders considerably on land at night. Where permanent water is available it is seen throughout the year. In other areas it aestivates. Annandale (*in* Boulenger 1920) records seeing them at Quetta (Pakistan) floating sluggishly on the surface of a well whose sides were frozen. It is fairly tolerant of brackish water as well as water

[6] McCann, C. (1932): Notes on Indian Batrachians. *J. Bombay nat. Hist. Soc. 32*:152-180.

[7] Anderson, J. (1895): Reptiles and Batrachians from Aden. *Proc. Zool. Soc. London.* p. 600.

polluted by industrial effluents. The food consists of insects and small vertebrates.

Rana tigerina (Daud.): Indian Bull Frog

Diagnosis. Size large; adult females occasionally exceeding 160 mm in snout to vent length. Males smaller. Snout obtusely pointed, projecting beyond the mouth. Tympanum distinct, equal to or slightly smaller than the diameter of the eye. First finger longer than second. Toes fully webbed but the web does not reach the tip of the third toe. Fifth toe with an outer fringe of web. Outer metatarsals separated by web nearly to the base. An obtuse inner metatarsal tubercle. Tibio-tarsal articulation reaches the eye or between the eye and the nostril. Heels overlap when folded at right angles to the body.

Skin smooth or granulate above with distinct longitudinal glandular folds. A fold from behind the eye to the shoulder. Ventral skin, smooth.

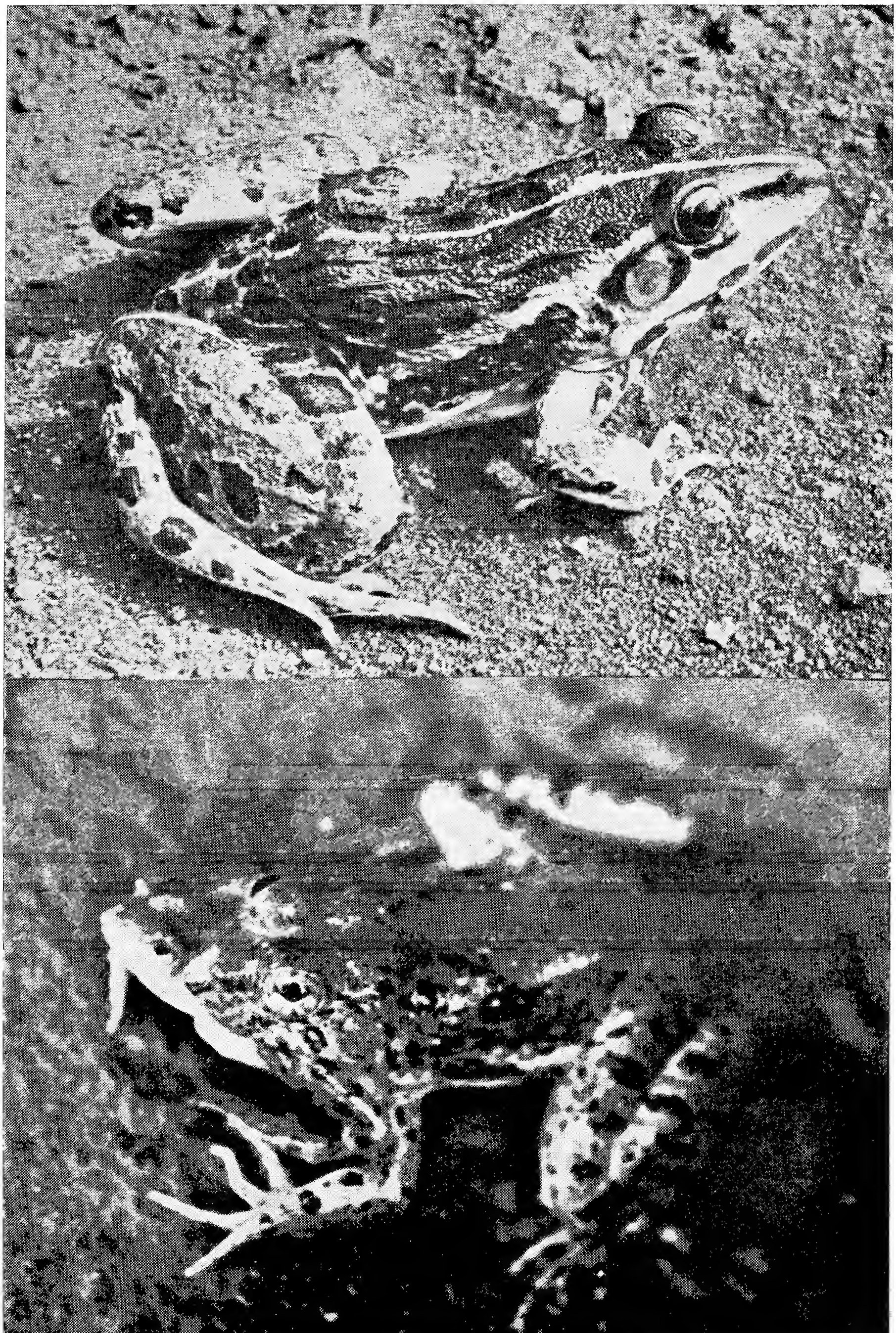
Colour. Olive green or brown above with darker markings. A light coloured vertebral streak from snout to vent often present. Limbs barred or spotted.

The juvenile is dark green above with dark brown markings and a black line along the side of the head.

Secondary Sex Characters: Male with external vocal sacs which are bright blue during breeding season. Forelimbs thick. The inner side of the first finger with a horny pad, velvety in texture, and greyish brown in colour. Males at breeding congregations in the Bombay area are bright yellow. This colour which is evident at breeding congregations changes to a sober brown if the animal is removed elsewhere.

Distribution. Throughout the Indian Subregion; Sri Lanka; Burma to Indo-China; South China; Formosa.

Breeding. As in the majority of Indian amphibia, the season coincides with the arrival of the monsoon rains. A detailed account of the breeding habits of the species in the Bombay area has been given by McCann (1932) and is summarised below. The first heavy showers of the monsoon bring frogs out of their aestivation retreats. The males in their lemon yellow livery congregate in rain water pools and ditches. Croaking loudly they alertly await the females which are fought over, the nearest male usually succeeds in holding on to the female and fending off competitors by kicking strongly with the hind legs. The spawn is laid in rain water pools and other transistory water. The eggs which float when laid, later sink to the bottom where they hatch. The tadpole is omnivorous and is usually a bottom feeder, only occasionally coming to the surface. According to McCann they are larvivorous.



Above: *Rana tigerina;* Below: *Rana cyanophlyctis.*
(*Photos*: *R. Whitaker*)

Above: *Rana breviceps;* Middle: *Rana malabarica* (*Photos*: *R. Whitaker*); Below: *Rana limnocharis* (*Photo*: *S. R. Nayak*) Male, Calling at night.

Habits. The largest of the Indian amphibia, the Bull Frog is widely distributed from the fringes of the deserts to *c* 2000 m elevation in the hills. Though not as aquatic as *Rana hexadactyla,* every spread of permanent or semi-permanent water has its complement of members of this species hiding in the grass or hollows at the very edge of the water, ready to dive in at the least sign of danger. Usually they blend so well with their habitat that it is difficult to locate them. In the non-breeding season they are silent but at the beginning of the rainy season their call, a deep toned, *oong awang* can be heard throughout the night, each new shower being welcomed with a fresh uproar. Another sound heard only when the frog is caught by a predator is an almost human scream. The frog sometimes gives out a chukle-like *kut kut kut* when caught by hand.

In the absence of permanent water in areas where there is a definite and prolonged dry season, the frog aestivates, singly or several together. In sandy areas they follow the falling water table; instances are on record of specimens being collected at depths of 6 to 9 metres. It is, however, a hardy species able to withstand considerable dessication.

The diet is catholic and anything in movement which can be swallowed is swallowed, the hands being used to thrust in the unwieldy sections of the prey. In addition to the normal diet of insects which varies with seasonal abundance of the prey species and is not selective, the Bull Frog is reported to have taken mice, shrews, birds up to the size of the Pitta (*Pitta brachyura*), snakes upto a metre in length, Spiny tailed Lizard (*Uromastyx*), toads, other frogs including smaller sized frogs of its own kind, land crabs etc. It is in turn fed on by waterfowl aquatic animals from fishes to crocodiles and various land animals. There is now heavy commercial exploitation of this species, the legs being exported. The rate of exploitation with selective collection of the larger forms is a serious drain on the breeding population and will affect the status of the species as well as its commercial importance unless reasonable safeguards are legislated. One of the adverse effects of removal of the frog now noticed in agricultural areas, is the increase in the number of land crabs and the consequent damage to wet land crops.

Rana crassa Jerdon 1853: Jerdon's Bull Frog

Diagnosis. Very closely resembles *Rana tigerina* but can be distinguished by its shorter leg; the tibio-tarsal articulation reaches only to the tympanum or the eye. The heels do not overlap when the legs are folded at right angles to the body. The inner metatarsal tubercle is distinctive being crescentic and nearly one to one and a half times the length of the inner toe.

Colour. Grey, brown, or green with darker markings. White below, occasionally with black spots on the throat.

Breeding. This species has been confused with *tigerina* and information on its larval stages are not reliable. The breeding habits need to be studied particularly with regard to the characters responsible for reproductive isolation from the closely allied *Rana tigerina*.

Distribution. Peninsular India and the Gangetic Plain. In the west coast upto Malabar. In the east up to Calcutta. Sri Lanka.

Habits. Apart from the fact that it is an excellent burrower unlike *tigerina* no separate records are available of its habits from those of *tigerina*, with which species it has been confused till recently. The young like those of *Rana tigerina* are seen in temporary rain water pools. I have collected adults near tanks in Tamil Nadu. The ecology and behaviour of the sympatric *Rana crassa* and *Rana tigerina* are excellent problems for investigation.

Rana verrucosa Gunther 1875

Diagnosis. Medium sized frogs (up to 61 mm in snout to vent length). Snout obtuse, tympanum distinct nearly the size of the eye. First finger longer than second. Tibio-tarsal articulation reaches nostril or tip of snout; heels strongly overlap when folded at right angles to the body. Toes fully webbed except the fourth which has two phalanges free. A dermal fringe to the fifth toe. Outer meta-tarsals separated nearly to the base. Two meta-tarsal tubercles, the inner larger. A short tarsal fold.

The skin of the back is extremely warty hence the name *verrucosa*. A fold from eye to shoulder. Ventrally smooth.

Colour. Dark grey or brown above with darker markings. A light vertebral streak if present interrupted by the markings on the back. Limbs and lips barred. Sides of the thigh patterned in black and yellow. Ventrally white.

Secondary sexual characters. Male with internal vocal sacs. Pads on the inner aspects of the first finger well developed and base of thighs granular in the male.

Breeding. Call not recorded. Breeding habits unknown. The tadpoles collected from a forest pool in Kerala in September has been described by Annandale (1915).[8] The mouth disc has five rows of teeth, a marginal row followed by an interrupted row in the upper and three

[8] ANNANDALE, N. A. (1915): Some undescribed tadpoles from the hills of southern India. *Rec. Indian Mus.* *15*:17-23.

unbroken rows in the lower lip. A gravid female was collected in south Kerala in November suggesting that there may be two breeding seasons in some areas.

Distribution. Hill forests of Kerala and Tamil Nadu up to 2000 metres.

Habits. Little known. I have collected this species from the side small fast flowing hill streams overhung with vegetation in the hill forests of south Kerala. Ferguson (op. cit.) reported them from similar situations. Annandale (op. cit.) records that "It is very abundant in the Travancore Hills" and that the species avoids small springs and pools and is usually found at the edge of streams and reservoirs. The coloration is to a certain extent cryptic.

Rana limnocharis Boie in Wiegmann, 1835: Indian Cricket Frog

Diagnosis. Small sized frogs, the majority of specimens seen hardly exceeding 35 mm in snout to vent length. Maximum size recorded, ♂ 51 mm, ♀ 64 mm. Breeding commences at a much smaller size, 20 mm ♂ and 23 mm ♀. Distinguished from other ranids by the smaller size and the brief webbing of the toes, usually half webbed with three phalanges of the fourth toe free. The tibio-tarsal articulation reaches the nostril when the leg is held along the body. Outer metatarsals united in the basal half or third. An inner and an outer metatarsal tubercles present. First finger longer than the second.

Skin warty above often with longitudinal glandular folds, short and interrupted. A strong fold from eye to above shoulder. Smooth below.

Male with a median subgular external vocal sac. The vocal sac area becomes black in the breeding season. A strong pad appears on the inner aspect of the first finger of the breeding male.

Colour. Usually grey or brown with darker markings. Lips and legs often with darker bars. A vertebral band of varying width often present. Ventrally white.

Distribution. East Asia from Pakistan to Japan. Apart from the typical form, three races have been named from India, namely *nilagrica* from the Nilgiri Hills in Tamil Nadu; *syhadrensis* from the western ghats near Bombay; and *andamanensis* from the Andaman group. The races are not readily distinguishable.

Breeding. Specimens in a ready to breed condition have been collected from March to August and October to January. The breeding season coincides with the monsoon rains and in areas like Trivandrum which receive both monsoons there are two distinct breeding seasons. However the occurrence of frogs in breeding condition in March and again in October-December at Mahableshwar in Satara Dt., Maharashtra,

which receives only the SW Monsoon cannot be easily explained. The species apparently does not have a fixed breeding season if conditions suitable for breeding are continuously available.

I have located and collected males calling from under the soil during the breeding season. McCann (1932) compares the call to the loud clatter of castanets and according to Minton (1966)[9] the call is "a series of loud staccato notes often delivered in bursts suggesting telegraphy". I would compare the call to that of the cricket.

Rana brevipalmata Peters 1871

Diagnosis. Medium sized frogs (snout to vent length 47 mm) closely resembling *Rana limnocharis* but can be separated by the longer hind limbs and shorter web between the toes. Snout pointed, tympanum distinct, first finger longer than second, hind limbs long the tibiotarsal articulation reaching the tip of the snout or beyond; heels strongly overlapping when the legs are folded at right angles to the body. Toes slender, feebly webbed, web not reaching to second phalange of toe. Outer metatarsals separated nearly to the base by web. Inner metatarsal tubercle prominent, half or more the length of the inner toe. A small outer metatarsal tubercle. Skin warty above, smooth below.

Colour. Greyish above with darker markings. White below.

Distribution. Malabar (Kerala); Nilgiris (Tamil Nadu).

Breeding. Male with a pair of vocal sacs and a strong pad on the side of the first finger. Breeding habits and tadpole unknown.

Habits. Unknown.

Rana malabarica (Bibr.) 1838: Fungoid Frog

Diagnosis. Medium sized frogs, the largest in the *BNHS* collection has a snout to vent length of 81 mm. Adults easily recognised by their distinctive coloration. Snout obtuse, projecting slightly beyond the mouth. Tympanum very distinct, slightly less or equal to the diameter of the eye. Tips of fingers and toes swollen. First finger longer than second. Tibio-tarsal articulation reaches the tympanum or the eye when the leg is held along the body. Heels overlap feebly when the legs are folded at right angles to the body. Toes feebly webbed, two or three phalanges of the fourth toe free. Subarticular tubercles on fingers and toes and inner and outer meta-tarsal tubercles large and prominent.

Skin smooth or granular above with a distinct dorso-lateral glan-

[9] Minton jr., Sherman, A. (1966): A contribution to the herpetology of West Pakistan. *Bull. American Mus. nat. Hist. 134*:55.

dular fold from above the tympanum to the groin. A shorter fold terminating in a large gland below the tympanum or is continued as a line of glands along the flanks. Ventrally granulate on belly and the underside of the thighs.

Colour. Back bright orange red, yellowish red, or crimson, from the tip of the snout to vent, distinctly separated from the black of the flanks along the canthus rostralis, upper eyelid, and the dorso-lateral fold. Upper lip white and the colour may extend along the line of glands on one sides. Ventrally white, uniform or spotted or marbled with black. Throat and chest often wholly brownish black or black. Legs brown or black barred or marbled with yellowish white. The barring in some of the young specimens (19 mm snout to vent length) resemble stripes.

Juvenile collected in May were greyish or yellowish white above instead of red (snout to vent length 14 mm).

Distribution. The Western Ghats and the lowlands west of the Ghats from Kasara Ghat in Nasik Dist., Maharashtra to Edanad, Chenganur Dist., Kerala. It is possible that the range extends further south but I have not seen it in the Trivandrum area nor has Ferguson (op. cit.) included it in his list of Travancore batrachia. The species is known from the Nilgiris and has been reported from Jagdalpur, Bastar, M.P. (J. C. Daniel & Selukar 1964).[10] It is possible that it may occur in suitable biotopes in other areas of the Eastern Ghats and perhaps in other areas of Peninsular India.

Breeding. Male with feebly developed external vocal sacs and a velvety pad on the inner aspect of the first finger at the breeding season and a glandular area on the anterior portion of the arm.

The breeding season commences with the onset of the monsoon and the northward extension of the rains along the range of the species. Females collected in Edanad, Kerala in March had enlarged ovaries with granular developing ova while the ovaries of specimens collected at Kanheri Caves, Bombay in the same month were dormant. In May females from Talewadi, N. Kanara were spent and just metamorphosed young were noticed. Females from the Bombay area collected in May and early June were gravid. McCann (1940) records a female with eggs in July and Chari (1962)[11] collected tadpoles of different stages

[10] DANIEL, J. C. & SELUKAR, T. G. (1964): Occurrence of the fungoid frog *Rana malabarica* (Bibr.) at Jagdalpur, Bastar District, M.P. *J. Bombay nat. Hist. Soc. 60*:743-744.

[11] CHARI, V. K. (1962): A description of the hitherto undescribed tadpoles of, and some field notes on the Fungoid Frog, *Rana malabarica* Bibron. *J. Bombay nat. Hist. Soc. 59*:71-76.

in August and the first week of September which supports McCann's observation that the species is a late breeder in the Bombay area. However it is possible that the species has an extended breeding season. The difference in size between the sexes is not very apparent but the largest specimen collected was a female.

The species breeds in still water, preferring shallow pools holding weeds or grass in forest or open country. The call which is given out by the male with sitting at the edge of such pools has been sylabilised by Abdulali (*in* Chari, op. cit.) as *wack, wack, wack*. My own observations support a treble version of this syllabilisation. However, McCann (1940) compares the call to the noise made by a tin rattle.

Chari (op. cit.) has shown that Boulenger's (op. cit.) description of the tadpole was based on misidentification. The tadpole according to Chari is straw yellow in colour and has the head and body blotched with brownish black and tail speckled with black. Mouth disc has one row of teeth on the upper lip and two, the inner interrupted, on the lower lip. Occasionally a short third row. Largest tadpole was 48 mm in total length. Metamorphosis was completed in two months and 18 days after collection of tadpoles. The period is perhaps less in nature.

Habits. This species prefers forested land though it has been recorded in open country particularly in the breeding season. McCann (1936) notes that it is semi-arboreal and may often be seen at considerable heights on trees. When on trees the red coloration of the back is said to resemble red bark fungus and the obliterative pattern of the rest of the body breaks the outline of the body merging the animal into the background; hence the trivial name "Fungoid Frog". McCann (1964) records that a powerful fungoid odour was given out under excitement by a specimen he caught at Tansa Lake near Bombay in May. Abdulali (op. cit.) records the odour of a specimen he collected in the same area as resembling burnt rubber. The frog is not as agile as other species and is easily caught and perhaps the coloration is apsomatic. I have seen them mainly at night though McCann (1932) states that they are diurnal. Later (1940) he noted that several specimens that lived in his house were nocturnal. In summer months a large number may gather in moist areas. Such congregations have been observed in the moist cisterns of Kanheri Caves at Bombay and P. B. Shekar (Per. Communication) who collected the species at Edanad in Kerala reports that he saw over 30 frogs inside a well in March sitting on the sides above the water. As noted by Abdulali (op. cit.) the species does not breed in such areas but in rain water pools. A land frog it is reluctant to enter water and avoids doing so except for breeding.

Subgenus *Tomopterna*: Burrowing Frogs

The species of this subgenus are usually seen only during the breeding season when they surface to breed. In appearance they resemble the burrowing microhylids but have a much larger head. The inner metatarsal tubercle is much enlarged, crescentic in shape and in most species exceeds the inner toe in length. It is the main burrowing tool. The food is ants and other subterranean insects. Three species occur in Western India.

KEY TO THE SPECIES OF *Rana* (*Tomopterna*) IN WESTERN INDIA

1 An outer metatarsal tubercle present; Tibiotarsal articulation reaches tympanum or posterior border of eye .... *rufescens*
1 Outer metatarsal tubercle absent; tibiotarsal articulation does not reach beyond shoulder 2
2 Snout shorter than eye in length; toes 1/4 to 1/2 webbed ...... *breviceps*
2 Snout as long as eye; web toes rudimentary .... *dobsoni*

Rana rufescens (Jerdon) 1854: Rufescent Burrowing Frog

Diagnosis. Medium sized frogs, the largest specimen in the *BNHS* collection has a snout to vent length of 43 mm. Head broader than long with rounded snout and distinct tympanum about half or slightly over half the diameter of the eye. First finger much longer than the second, third equal to or slightly longer than the first. Tibio-tarsal articulation reaches tympanum or posterior border of the eye. Heels slightly overlapping when legs are folded at right angles to the body. Toes feebly webbed. One phalange of 1st and 2nd toes free; 2 phalanges of 3rd and 5th toes and 3 phalanges of 4th toe free. Sub-articular tubercles of fingers and toes prominent. Inner meta-tarsal tubercle large, nearly one-third the length of the inner toe and is compressed and crescentic in shape. A small outer meta-tarsal tubercle.

In the field it can be easily confused with *Rana limnocharis* but can be distinguished by the size and shape of the meta-tarsal tubercle and the much more rounded snout.

Skin with numerous warts above and two glandular ridges forming an inverted open V between the shoulders. A glandular fold from the eye to the shoulder. Ventrally smooth except on the back of the thighs where it is granular.

Colour. Brown above with darker spots and marblings. Occasionally a crossbar between eyes. Lips and limbs barred. Most specimens have patches of varying shades of red on them and in some almost the whole dorsal surface may be brick red.

Distribution. Salsette Island, Bombay, southwards along the Western Ghats to Malabar.

Breeding. The male has external vocal sacs appearing as blackish folds on the sides of the throat in the breeding season. A strong pad on the first finger. Call not recorded. Females collected in June at Kanheri Caves, Salsette Island, Bombay and at Gersoppa, North Kanara were gravid. Gravid and spent females have been collected in the Koyna area in July. Abdulali (1962)[12] records a pair in copula in June at Kanheri Caves. The tadpole has not been described so far.

Habits. Little known. It is an uncommon frog. A burrower, it is mainly seen during the early monsoon months, when juveniles and adults have been collected near water and in grass. Adults have been seen at other times of the year in forests under logs and stones.

Rana breviceps Schneider 1799: Indian Burrowing Frog

Diagnosis. Medium sized frogs. Adults in the *BNHS* collection average 56 mm (range 43 to 65 mm) females and 48 mm (range 41 to 56 mm) males in snout to vent length. Snout short, less than the diameter of eye in length, rounded. Tympanum distinct, approximately three-fifth the diameter of the eye. First finger considerably longer than second, equal to or a little shorter than the third. Tibio-tarsal articulation reaches the shoulder. Heels do not meet when the legs are folded at right angles to the body. Web on toes does not reach the last phalange of the first to third and the fifth toes. Two phalanges of the 4th free. Outer metatarsals bound together. Sub-articular tubercles prominent. Inner metatarsal tubercle, large, compressed, crescentic and more than the inner toe in length. No outer tubercle.

A small circular tubercle occurs on the tarso-metatarsal joint in some specimens from south India. The presence of this tubercle was first noticed in specimens collected at Trivandrum in Kerala (Bhaduri & Kirpalani 1954)[13] and the occurrence of this tubercle was recorded in specimens from Sri Lanka and India south of *c.* 17°. Specimens from the range of the species north of 17° latitude lack the tubercle. However specimens without tubercle also occur south of latitude 17°. While collecting at Trivandrum the specimens studied by Bhaduri & Kripalani, I was struck by their remarkable resemblance to species of the Microhylid genus *Uperodon* rather than the *Rana breviceps.* I was familar with in the Bombay area. The colour too was markedly different being greyish with darker markings instead of the uniform brown of the back in specimens from the Bombay area. It is possible that the southern

[12] ABDULALI, H. (1962): An account of a trip to the Barapede Cave, Talewadi, Belgaum District, Karnataka State, with some notes on Reptiles and Amphibians. *J. Bombay nat. Hist. Soc.* 59:228-237.

[13] BHADURI, J. L. & KIRPALANI, MIRA, (1954): Notes on the frog *Rana breviceps* Schneider. *J. Bombay nat. Hist. Soc.* 52:620-623.

form with the tarsal tubercle may be a sibling species but more information is needed on the ecology and behaviour of the frog for a conclusion.

Skin smooth or finely granular on the back and coarsely granular on the belly and underside of the thighs. Throat and chest smooth. Occasionally glandular folds and warts on the back. A glandular fold from behind the eye to the shoulder.

Colour. Uniform light or dark brown or grey above, occasionally spotted or marbled with yellow or white. Ventrally white. Throat sometimes brownish. Lips barred. Thighs ventrally marbled with yellow or white. A yellow vertebral streak often present. A black canthal (snout) streak often present, particularly in juveniles. Lip white in some specimens from Bombay.

Distribution. Throughout the Indian Peninsula from the Himalayas to the Cape, Nepal, Burma, Sri Lanka.

Breeding. Males with vocal sacs forming folds on the sides of the throat. Some specimens with an additional fold across the throat in front of the shoulder. Throat black in breeding males. The throat and chest of breeding males granular and present a finely speckled appearance from the presence of pustules.

The call is a soft *awang* which can be heard at a good distance. The breeding season commences with the onset of the monsoon. There is no particularly preferred site for the spawning. I have collected tadpoles in cisterns, rain water pools, pools in quarries, in small hill streams and in shallow and fairly deep water with and without weeds. Females with gravid and spent ovaries have been collected in June and July suggesting that individuals mature at different times. Tadpoles at various stages of development have been collected from the beginning of June to end of July in the Kanheri Caves area of Salsette Island, Bombay, and in May at Talewadi, Karnataka. At Trivandrum, tadpoles were collected in October. Apparently there are two breeding seasons at Trivandrum coinciding with the two monsoons. The tadpole is a bottom feeder and the time of development is 18 to 20 days (C. R. N. Rao 1915).[14]

The juvenile measures 8 to 10 mm at metamorphosis. Juveniles have been collected in June and July in the Bombay area and at Surat Dangs. I found the juveniles to be very numerous around rock quarry pools at Tuticorin in Tamil Nadu, in January. These were pale brown with darker spots and resembled young *Rana crassa* found in the same area but could be separated by the shorter webbing of the toes.

[14] RAO, C. R. N. (1915): Notes on some south Indian Batrachia. *Rec. Indian Mus.* *11*:31-38.

Habits. A burrowing species, there is little information on their habits. They are seen only during the early monsoon months when they surface to breed. The juveniles are commonly seen for a short period after they metamorphose hopping around the pools from which they emerged.

Rana dobsonii Boulenger 1882: Dobson's Burrowing Frog

Described on the basis of two females collected at Mangalore, south Kanara, measuring 55 mm and 57 mm in snout to vent length. The species differs from *Rana breviceps* only in the snout being equal to the eye in length and the web the toes being rudimentary. I have not seen this species.

(*to be continued*)

Miscellaneous Notes

1. NOTES ON THE STATUS OF THE NOSELEAF BAT, *HIPPOSIDEROS SPEORIS PULCHELLUS* ANDERSEN (MAMMALIA: CHIROPTERA: RHINOLOPHIDAE)

While preparing a catalogue of Chiroptera in the collections of the Zoological Survey of India, Calcutta, specimens of *Hipposideros speoris speoris* (Schneider) and *H. speoris pulchellus* Andersen presented some difficulty in separation. An attempt is made in this paper to settle the problem. Notes on geographical distribution of the species are also included.

MATERIAL: 1♀, Baroda, Gujarat: 19♂, 13♀, Coorg, Kanara, Bellary (Vijayanagar), Gadag, Belgaum and Deccan, Karnataka: 6♂, 4♀, Trivandrum, Kerala: 2♂, 6♀, 1 (unsexed), Salem, Nagercoil and Tiruchirapalli, Tamil Nadu: 2♂, 1♀: Cuddapah and Palkonda Hills, Andhra Pradesh: 10♂, 2♀, 5 (unsexed): Sri Lanka.

TABLE

MEASUREMENTS (IN MM) OF *Hipposideros speoris* (SCHNEIDER) FROM THE DISTRIBUTIONAL RANGE OF *H. s. speoris* AND *H. s. pulchellus*

	Mysore (Bellary)	Peninsular India (excluding Bellary)	Ceylon
EXTERNAL:	7♂, 6♀	23♂, 15♀	10♂ 2♀
Length of forearm:	47-52 (50.1)*	49-54 (51.4)	50-54 (52.1)
Length of tibia:	20-23 (21.8)	19.5-25 (21.7)	19-24 (21)
Length of foot including Claws:	8-9 (8.7)	7-10 (8.4)	7.5-9.5 (8.8)
SKULL:	2♂, 4♀	12♂, 5♀	4♂, 2♀
Total length:	18-19 (18.3)	18.1-19.2 (18.4)	18-19 (18.6)
Zygomatic width:	10.3-11.5 (10.8)	10.3-11.7 (10.9)	10.6-11.4 (11.1)
Cranial width:	8.5-8.8 (8.7)	8-9.7 (8.4)	8.2-8.9 (8.5)
Length of upper tooth row ($c—m^3$):	7-7.4 (7.1)	6.8-7.3 (7.1)	7-7.5 (7.3)
Length of lower tooth row ($c_1—m_3$):	7.5-8.2 (7.7)	7.2-8 (7.8)	7.5-8.3 (7.9)
Length of mandible:	12.6-13.5 (13)	12.5-13.5 (13.1)	12.8-13.5 (13.2)

* Average measurements given in parentheses.

Andersen (1917) separated *pulchellus* (Bellary population) from *speoris* only on average measurements: skull length 18-19.8 mm (18.8) *vs.* 19-20.3 mm (19.7) and forearm 45.8-51 mm (49.5) *vs.* 49.8-54 mm (52). From a study of the material of the species from the range of the two 'subspecies', I find that there is no difference in their external or cranial measurements (Table), as mentioned by Anderson (1918). I would therefore, treat *H. speoris pulchellus* Andersen as a synonym of *H. speoris speoris* (Schneider).

The species has hitherto been known to range from Peninsular India, Sri Lanka east to Java, Sumatra and Timor. Brosset (1962) mentioned its absence in Gujarat but one specimen examined by me from Baroda (Gujarat) belongs to this species.

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Desert Regional Station,
Zoological Survey of India,
Jodhpur (Rajasthan),
July 10, 1973.

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2. A NOTE ON ECOLOGY OF THE GOLDEN LANGUR (*PRESBYTIS GEEI* KHAJURIA)

Introduction

A survey of Manas Sanctuary was undertaken to investigate the distribution of the fauna and to ascertain the present position of the Golden Langur (*Presbytis geei* Khajuria) in the Sanctuary area. The period of survey was from 8th to 18th January 1974. The area within and around the sanctuary were covered by Jeep, on foot, by boat and on elephant back. This report also includes findings of 4 surveys in Garo Hills area pertaining to *Presbytis geei*.

DISTRIBUTION

Gee (1961) gave the distribution of the species as the areas east of River Sankosh and west of River Manas in north west Assam. Further, he presumed (1961, 1964) from reports of sportsman and animal dealers that Golden Langur is present in small numbers in Garo Hill district of Meghalaya and foot hill areas of Khasi Hills although he himself could not spot a single one in these areas. Initiated by a report to the Bombay Natural History Society and a request from the Society to undertake a survey in Garo Hill a serious search was started by Eastern Regional Station, Zoological Survey of India and in February 1970 a party headed by Dr. G. M. Yazdani (10 Feb.-28 Feb. 1971) surveyed certain areas of Garo Hills (Tikrikillah, Tura, Baghmara, Rongdong, Dudhnai) but could not spot a single *P. geei*. A second survey was undertaken in 1971, led by Dr. R. S. Pillai (7th April-16 April 1971) in those areas (Dudhnai, Damra, Darugiri) where Golden Langur was reported but the result was negative. Later in April 1973 and November 1973 two more extensive surveys were made, headed by one of the authors (S. Biswas) in Garo Hill district including areas e.g., Dhudhnai, Dainadubi, Bangshi, Wageasi, Rongjeng, Songsok, Rongrengiri (4 April-24 April 1973) and Bajengdoba, Anogiri, Rongram, Songsok and Damra (3 Nov.-24 Nov. 1973) but no Golden Langur could be observde. It may further be added that the junior author (S. Biswas) had also surveyed Goalpara district of Assam adjoining Garo Hills but failed to notice any Golden Langur in the area.

The present survey confirms Gee's (op. cit.) observation that Golden Langurs are not found on east bank of Manas, as a survey in the areas extending from Mathonguri *via* Falaguri to Kahitama did not reveal any Golden Langur. It also supports earlier observation of its occurrence in west bank of Manas in Bhutan Forest areas as on 4 different dates troops of Golden Langur were observed only in a part (10 sq km) of this evergreen forest.

STUDY AREA

The present survey included an area of 50 km on each side of river Manas from Mathonguri to Kahit and 10 km on the west bank of Manas in the forested hills of Bhutan. The Golden Langur, as already stated, was seen only in the Bhutan side; this area has steep hills covered by evergreen forest with a gentle slope near Manas river. The forest in study area in the foothill has tall trees such as *Lagerstroemia parviflora* Roxb. [Assamese: Sida], *Salmalia malabarica* DC. (Schat & Eudl.) [Assamese: Simul], *Dalbergia sissoo* Roxb. [Assamese: Sisoo],

Amoora wallichi King [Assamese: Amaril], *Trewia nudiflora* Linn. [Assamese: Bhelkor], *Ficus* and *Terminalia* spp. besides some shrubby undergrowth.

In the area two troops of Golden Langurs observed, no solitary male was seen. The home range of the troops during the survey appeared to be 3 × 2 km each with an overlapping region.

Troop organisation

Both troops had only one adult male but more than one adult female and adolescent animals of various age groups. In troop 1 only one female with infant was seen whereas in troop No. 2, two females with infants were observed. Troop 1 consisted of 9 members including one adult male, one adult female, 2 subadults and 1 infant and troop 2 consisted of 6 members 1 adult male, 1 subadult male, 2 adult females, 2 infants.

Feeding behaviour

Gee (1961) listed nine trees on which the Golden Langurs were seen feeding (Buds, leaves, flowers and fruits); in the present study the langurs were observed feeding on flowers of *Salmalia malabarica,* (and this appears to be the most preferred food), and fruits of *Amoora wallichi* and *Trewia nudiflora* the last two food plants were not included in Gee's (op. cit.) list. The langurs pick up flowers of *Salmalia* in quick succession and throw the petals down after eating the calyx; while eating fruits of *Amoora* and *Trewia* they were never seen to eat the whole and often after eating a part throw the rest to the ground. Tall branches of trees were always selected for eating and movement from tree to trees or branches was always swift and together. The feeding time varied from 8.30-9.30 a.m., 11.30 a.m. to 1 p.m., 1.30-2.00 p.m. and it appeared that feeding usually coincided with bright sunshine as on the second and third day mentioned earlier, the sky was overcast till noon.

Movement

Golden langurs appear to prefer tall trees for movement and during the present survey they were never seen below 8 m. They never seemed to be bothered by our observation and even looked down at us from tall trees. They are fascile in their movement from one tree to other or from a higher to lower branch, always seen to leap straight and hardly missing the next target. When disturbed, the troop moves very

fast from one tree to the next and continues moving till they reach a suitable tree with foliage cover.

Resting, agression, vocal communication

The resting langurs usually groom each other. The infant sticks close to the breast of mother and the adult male usually sits on a higher branch looking around.

Only on one day (15-1-1974) was an adult male seen chasing a subadult male on two different occasions and hitting him, when the subadult and the females, screeched. The loud joyous sounding whoops so often made by the common langur [*Presbytis entellus* (Dufresne)], was never heard.

Mating activity was not observed during the present study.

Relationship with other animals

The Common langur [*P. entellus* (Dufresne)] and the Capped langur (*P. pileatus* Blyth) present otherwise in Manas Sanctuary area were never seen in association with the Golden Langur.

The only animal which was observed to share food from the same tree with the golden langur was the Malayan giant squirrel *Ratufa bicolor* Sparrmann, and the langur did not seem to object to the presence of these animals.

Colour

The colour of different members of the troops vary considerably. The young as also the females appear to be silvery white to light golden whereas the adult male always showed rich golden colour in most part of its fur. Gee (op. cit.) stated that cream or white colour was seen in warm weather and the rich golden to chestnut colour was restricted to colder months but our observations reveal colour differentiation in age and sex groups.

Discussion

During the present study it became obvious that the west bank of Manas in Bhutan forest region has become much less dense than during Gee's earlier observation period and consequently when the golden

langurs come to the fringe areas of forest near the elephant track III, they can be more easily observed. Due to complete protection these animals appear to have become accustomed to human beings.

The infants seen with the troops seemed to be 1-2 months old and as such the young must have been born during November. As reported by the Divisional Forest Officer in charge of Gauhati Zoo, the langur in captivity does not seem to have any particular mating period but the two babies born in captivity were during July and August.

The existence of Golden Langurs in Garo hill district is still to be proved. Gee's (op. cit.) personal attempt as well as four extensive surveys made from this station did not yield a single evidence so far. The definite area of distribution remains between Sankosh and Manas, in a strip of country along the Bhutan border.

The migration of these langurs to the high hills during summer has yet to be investigated but the Divisional Forest Officer of Bhutan forests informed the senior author that he has seen Golden Langurs upto 1600 m on Bhutan Hills on west bank of Manas, during summer months.

Besides the two troops seen during the present study, it is reported that two other troops exist on the Bhutan side of Manas within an area of 15-20 sq km and future studies may well provide data from 4 troops in the study area. The elephant track in the Bhutan forest offers excellent opportunity to track these animals.

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We are thankful to Mr. Barua, Chief Conservator of forests, Mr. M. M. Islam, C.F. (Development) and the officers and personnel of Assam Forest Department in Manas Sanctuary area and D.F.O., Bhutan Forests and his staff for their kind collaboration during the present survey. We express our thanks to the Director, Zoological Survey of India, Calcutta for permission to undertake the present survey.

Eastern Regional Station,
Zoological Survey of India,
Shillong 3,
April 16, 1974.

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3. A NOTE ON THE BREEDING HABITS OF FOUR-HORNED ANTELOPE (*TETRACERUS QUADRICORNIS*) IN CAPTIVITY

Specimens of the Fourhorned Antelope or Chowsingha have been received from different parts of Orissa and exhibited at Nandankanan Biological Park, Orissa from time to time. Some notes on the breeding habits of this species observed in this Park are presented here.

So far eleven young have been produced in six births including five twins with an average of 1.83 young per litter. Out of these, 4 were males and 7 were females. The sex ratio of males to females was 1:1.75. The six births were distributed as follows: January, 3; March, 2; and April, 1.

The weight and size at birth of seven young born during 1973 and 1974 were as follows: Weight—from 0.75 to 1.2 kg with an average of 1.04 kg; length from tip to tip—from 42 to 45 cm an average of 43.5 cm and the shoulder height—from 24.5 to 27 cm with an average of 25.2 cm. The one young which weighed 0.75 kg and measured 42 cm at birth died on 13th day.

One female born here on 15-iv-1972 has given birth to a single young for the first time on 12-i-1974 at the age of 1 year, 8 months and 29 days or say 1 year and 9 months. This remained with an adult male throughout this period. Another female received in this Park on 13-v-1971 at an estimated age of about one month gave birth to twin young for the first time on 19-i-1973 at an estimated age of about 1 year and 9 months. This had remained with an adult male from the estimated age of about six months. Taking the gestation period as 8 to 8½ months (Prater 1971) the age of sexual maturity of these two females can be said to be about one year to one year and one month.

One female gave birth thrice during the period from April, 1972 to January, 1974 i.e. 15-iv-1972, 29-iii-1973 and 9-i-1974. So the interparturition interval observed twice in this animal was 347 days and 285 days respectively.

The breeding season is in the hot weather and rains and young are born from October to February (Prater loc. cit.). Asdell (1964) states that in the London Zoo three births had taken place in February and others in May and June and twins were produced in three of the five births. According to Walker *et al.* (1964) mating takes place during the rainy season and the young, one to three in number, are born in January or February.

At birth a fawn of fourhorned antelope weighed 2¼ pounds, measured 15 inches in length and the shoulder height was 10 inches (Shull 1958). The average weight of four young of this species was 1.081 kg, the average length was 46.3 cm and the average shoulder height was 27 cm at birth (Acharjyo & Misra 1972).

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WILD LIFE CONSERVATION OFFICER, OLD SECRETARIATE BUILDING, CUTTACK 1 (ORISSA), — R. MISRA
March 16, 1974.

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4. OBSERVATIONS ON CONFLICT AMONG MALES OF BLACK RAT *RATTUS RATTUS FRUGIVORUS*

Incidence of mortality in conflict among males of black rat *Rattus rattus* L. is supposedly very low (Barnett 1958). Evidence presented herein, however, suggests that in sub-species *Rattus rattus frugivorus* deaths in such interactions may not be unusual in some situations.

OBSERVATIONS

(1) In aggressive rodents caught together males often fight until one is killed by the time traps are collected (Spillett 1968). The same was observed twice in a total of 132 trappings with multiple-catch wonder traps. An apparently senile male with grey hairs and pathological testis (weight 218 gm) was killed in the trap by a younger male (wt. 192 gm) while on another occasion a healthy male (wt. 146 gm) was found to have died in a fight with one of its own age (wt. 152 gm). This

Table 1

Colony	Weight of resident *alpha* gm	Weight of interloper gm	Mortality in days	Final weight of interloper	Wounding
Bisexual	160	146	0.08	143	Superficial
		166	1	162	Superficial
		122	2	114	Superficial
		117	3	108	Testis & viscera pulled out
Bisexual	190	200	1	194	Superficial
		180	1	176	Superficial
		157	5	143	Superficial
		135	6	105	Superficial
		106	1	101	Superficial
		70	2	–	Testis & viscera pulled out
Bisexual	192	212	1	201	Superficial
Bisexual	156	160	0.12	158	Superficial
Bisexual*	142	117	3	102	Superficial
Bisexual*	175	130	5	113	Superficial
All-male	196	119	3	107	Superficial
		132	–	–	Superficial
		172	–	–	Superficial

* Housed in cages. All others in pen.

reflects that such mortality among males is not unusual in natural environment.

(2) High rate of mortality was recorded for males released in bisexual colonies maintained in pens (9 × 5 × 4′). Mature males of good condition were killed by the resident males sooner than weaker ones which wasted away over a period of several days (Table 1). One resident male killed all the six females introduced into its pen. Its behaviour was consequently adjudged as atypical. It was also killed on being released in another colony.

Agnostic interactions in pens were not quantitatively evaluated but there was apparently much jumping and chasing before the interloper was caught by the residents. To escape pursuit the rats often waded into drinking water kept in a tray. Recovered later, when dead, they were often found wet with swollen feet. Body injuries otherwise were superficial except in case of two young males (wts. 70 & 117 gm) whose testes and viscera were pulled out.

(3) 12 interlopers were released in as many bisexual colonies housed in cages (32 × 18 × 18″). Only two males died after six days while the rest survived the period of observation extending to three weeks. Threatened by resident males, the interlopers invariably hung to the side or roof of the cage. When chased they ran and jumped frantically disturbing the nest box, water tray and also the females in the process. This seemed to 'displace' the aggressive drive of the resident males. The interlopers were thus not pursued with vigour and the survivors accordingly did not show any serious injury. The fur coat was, however, generally thin.

(4) Likewise only a few interlopers were killed in all-male colonies. Their introduction invariably triggered a general fight in the colony which was surmised as the absence of social stability in it. It was clear thus that the interlopers were released before any one male and established its social ascendancy.

(5) A number of males were introduced into cages housing a lone male. None of the interloper was killed in the following eight days. But the condition of some of them had apparently deteriorated. Had the period of observation been extended some deaths might have been recorded. This, however, could not be done.

Individual weights of all the interlopers were compared to that recorded later at the time of autopsy. Maximum decrease in weight (10 to 20%) was shown by the rats which appeared to have wasted away after release. The loss of weight in case of other rats killed as also of the survivors was only marginal.

Discussion

The slender and lightly built black rats climb well. Simulated labo-

ratory facilities for studying their agnostic behaviour needs to be spacious with even surfaces to ensure perpetual contact between the combatants. This was possible in the pens but not quite so in the cages. This may have created the difference in mortality recorded for the same situations in the two set ups.

Resident males attacked the interlopers in all situations to defend their territory against strange males. The intensity of attack on them was particularly heightened by the presence of females. Thus the incidence of male mortality recorded in bisexual colonies housed in pens equalled that reported for more aggressive species as *Rattus norvegicus* (Barnett 1958; *et al.* 1968). Otherwise it was comparatively insignificant.

The interlopers which lost weight rapidly and died slowly in pens and cages can be classified as the 'omega' males (Barnett 1958). Accordingly others able to maintain their weights in cages or killed with marginal loss of it in pens were the 'beta' males. Thus males of this species are also stratified in three social ranks—dominant alphas (residents) and the sub-ordinate betas and omegas. The distinctions between them, however, may not be very sharp like that noted among males of brown rat *Rattus norvegicus* (Barnett 1958).

Death of the residents following successive fights with interlopers shows that the general capacity of the males of this species to tolerate stress of agnostic interactions is very limited. Implied in this are some general facts about the aggressive behaviour of this species e.g. (1) it is less aggressive, (2) any one male fails to dominate several others, as in all-male colony and (3) that it restricts the size of social units. Only a few males thus may succeed in co-existing and the number of females associating with them would obviously depend on their ability to cover them. In any case then the total number of rats in the colony would be limited.

Apparently the behaviour of the species requires analysis in detail. This is being attempted in my laboratory.

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April 4, 1973.

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5. NOTE ON A COLLECTION OF RATS FROM GOREGAON-MALAD IN BOMBAY

It has been noticed that the species frequency in the rat population from the City of Bombay has changed (Deoras 1966). During a survey of the rats in Bombay it was observed (Joshi 1961) that *Rattus rattus* predominated in former suburbs like Dadar. As urbanisation increased the field rat was found to predominate even in the heart of Bombay, when it was only 2 per cent in the total collection in 1910 (Deoras 1966). During the studies in the eastern suburbs of Bombay it was noticed that the house rat still predominated in the fields of Bhandup (Joshi 1966). But the ex-ratio of both *Rattus rattus* and *Bandicota bengalensis* in the collection was different than that erstwhile found in the heart of Bombay or its suburbs like Dadar (Prasad 1967). The area around Bhandup is becoming heavily industrialised even though there are fields surrounded by a rural type of housing. The western suburbs of Bombay have fields, hills and forest vegetation and it has not yet been heavily industrialised. The frequency of different species in the rat population and the sex-ratio had not been seen for the western suburbs. The present studies were started with this idea, in December 1972 and this note gives an idea of the frequency of species in the rat population in Goregaon-Malad as compared with the collections from the heart of Bombay, and other suburbs (Table 2).

Table 3 gives the percentage of species of rats collected in this area, wherein *Rattus rattus* is 69 per cent and *Bandicota* 13.9 per cent. In both species the females predominate; a phenomenon similar to that seen in the heart of Bombay as well as the erstwhile suburbs. Both figures are just the opposite of what was seen in 1967 at Bhandup. Table 1, gives the percentage of *Rattus rattus* and *B. bengalensis* collected in the entire Bombay, in the suburbs only and their sex-ratio in the heart of Bombay, and erstwhile suburbs as compared to what was available at Bhandup.

The second point of interest is that at Goregaon-Malad *Rattus rattus* continuously dominates for all the six months as opposed to *B. bengalensis* in the entire Bombay. However the *R. rattus* predominance is common to both the suburbs i.e. Bhandup and Goregaon-Malad.

Thirdly *R. norvegicus* is not seen the suburbs and the various spe-

COMPARATIVE ACCOUNT OF THE PERCENTAGE OF *R. rattus* AND *B. bengalensis* COLLECTED IN ENTIRE BOMBAY, SUBURBS ONLY, GOREGAON-MALAD, BHANDUP ONLY; AND THEIR SEX RATIO FOR THE WARDS AS WELL AS LAST TWO AREAS, 1973.

Percentage of *R. rattus* in entire Bombay	Percentage of *B. bengalensis* in entire Bombay	Percentage of *R. rattus* from suburbs only	Percentage of *B. bengalensis* from suburbs	Percentage of other rats in the collection (entire)	
22.5	46	67.1	13.1	*R. norvegicus*	17.7
				B. indica	0.4
				Mus. muculus	3.9
				Suncus caeruleus	9.6

Heart of Bombay (Tardeo, Kamathipura and Nagpada) *R. rattus*		Heart of Bombay Percentage of *B. bengalensis*		Erstwhile suburbs (Dadar, Mahim and Dharavi) Percentage of *R. rattus*		Erstwhile suburbs Percentage of *B. bengalensis*	
14.7		43.4		25.2		48.2	
M.	F.	M.	F.	M.	F.	M.	F.
34.0	55.6	39.6	49.2	32.0	56.5	35.0	52.7

Percentage of *R. rattus* from Goregaon-Malad		Percentage of *B. bengalensis* from Goregaon and Malad		Percentage of *R. rattus* from Bhandup (Fields only) 1966-67		Percentage of *B. bengalensis* from Bhandup (Field) 1966-67		Percentage of other rats collected at Bhandup (Field-Area) 1966-67	
69.5		13.9		26.43		19.9		*B. indica*	0.52
M.	F.	M.	F.	M.	F.	M.	F.	*Laggada nagarum*	45.3
36.5	57.5	38.83	51.35	69.0	30.0	75.0	24.6	*B. gigantia*	6.3
								Golunda gujerati	1.6

M: Male F: Female

TABLE 2

COMPARATIVE PERCENTAGE OF COLLECTION OF RATS FROM THE ENTIRE BOMBAY AND THE WESTERN SUBURBS OF GOREGAON AND MALAD

	R. rattus		*B. bengalensis*	
	Entire Bombay	Goregaon and Malad	Entire Bombay	Goregaon and Malad
December, '72	23.6	68	44.5	—
January, '73	25.4	69.3	43.9	12.7
February, '73	23.6	69.3	46.2	14.5
March, '73	21.7	69.4	48.8	16.7
April, '73	19.5	71.05	50	14.11
May, '73	19.3	71.7	47.9	14.57
June, '73	20.4	70	48.1	10.77

TABLE 3

DETAILS OF DIFFERENCES IN THE *R. rattus, B. bengalensis* COLLECTIONS AT GOREGAON AND MALAD

(A) Total all rats collected:		16,623	
Rattus rattus sp. in this collection:		8,777	
Percentage of *R. rattus* in the collection:			69.5%
Rattus rattus rufescens Grey:		8,657	
	Males	2,791	32%
	Females		57%
	Immature		11.2%
R. rattus wroughtoni Hinton:		141	
	Males		58%
	Females		83%
Rattus rattus (*rufescens*) Grey:			
With white patches on the pectoral region:		6	
	Males		50%
	Females		50%
(B) Total *Bandicota* Collected:		Nos. 1,479	
Percentage of *B. bengalensis*			73.86%
	Males		38.83%
	Females		51.35%
Percentage of *B. indica*			26.13%
	Males		35.93%
	Females		52.44%
Total *B. indica* collected		Nos. 384	
Percentage of *B. indica malabarica* collected in the total of *B. indica*			17.00%
	Males		36.60%
	Females		63.39%

cies of rats (Table 1) found at Bhandup are not represented at Goregaon-Malad.

The studies are being continued and the detailed results would be soon published.

We are extremely thankful to the University Grants Commission for the grant to the Senior Author; to Bombay Municipal Corporation for permitting the collections; and to the Principal, S.S. & L.S. Patkar College for giving facilities to continue the work at Goregaon.

BIOLOGY DEPARTMENT,
S.S. & L.S. PATKAR COLLEGE,
GOREGAON (WEST),
BOMBAY 400 062,
December 6, 1974.

P. J. DEORAS
MANORAMA MITTAL
M. S. PRADHAN

6. THE INDIAN MOORHEN (*GALLINULA CHLOROPUS*) BREEDING IN KERALA

Sálim Ali says in the BIRDS OF KERALA that the breeding of the Indian Moorhen has not been recorded in Kerala. M. C. A. Jackson, too, does not seem to have found it breeding. In April 1974 two Zoologists and I watched Moorhens with chicks at Munnar, the High Ranges, Kerala State.

On 7-iv-1974 Sri S. Satheesh Chandran Nair, Research Scholar in Zoology, Kerala University, and I were watching birds near the Ramaswami Iyer Head Works of the Kerala Electricity Board. At 17.30 hrs, in the stagnant waters of the stream above the spillway, we found an Indian Moorhen with two tiny, jet black chicks. While the parent swam about near the thick growth of reeds on the Park-side bank, the young ones walked about on the floating mat of dead and broken reeds at the edge of the reed-bed. The young could swim, though they did so only when they had to cross a gap in the mat of reeds. Half an hour later in a different part of the pool we came across the same or another pair of Moorhens with two chicks of the same age and colour as the first.

On the 14th we were again at the same spot at 1745 with Sri V. S. Vijayan, Research Scholar working under Dr. Sálim Ali, and we saw a single pair of Moorhens only. They had two chicks with them, but these were more than double the size of those seen a week earlier. Moreover these had the throat and the underparts whitish. The fact that no other pair of Moorhens could be found on the 14th makes me wonder whether there were, after all, only this one pair in the area. If that sus-

picion is correct, the rate of growth of juvenile Moorhens is quite remarkable.

UNIVERSITY COLLEGE,
TRIVANDRUM,
May 28, 1974.

K. K. NEELAKANTAN

7. UNUSUAL BEHAVIOUR OF *PSITTACULA KRAMERI BOREALIS*

Over the past two months I have noticed what I believe to be rather unusual behaviour by the Common Green Parakeet.

We are quite accustomed to seeing these birds in large flocks feeding on the various varieties of *ficus*. We have a large *Ficus bengalensis* on our own compound which, when in fruit, is full of parakeets.

This year they have taken to feeding on *Acacia auriculiformis* stripping first the young shoots, and then the mature phyllodes and bark, leaving the tree completely denuded, and all terminal branches absolutely bare of bark.

We have a number of these trees in the campus and the surprising thing is that instead of large flocks, and they come in their hundreds, descending haphazardly and feeding indiscriminately, these birds behave in an entirely systematic manner and appear to be almost controlled.

From early morning the flocks descend upon a single tree and remain feeding there, in their customary wasteful fashion, until about 0800 IST, when they leave *en masse*. If disturbed they rise and circle to return to the same tree when the cause of their alarm has disappeared.

In two or three days, dependent upon size, the tree will have been stripped to its bare frame and then only do the flocks move on to the next tree, which in many cases may be as little as ten yards away.

In this systematic manner these birds have now denuded a dozen trees, which I am pollarding in an attempt to save them.

I should be interested to learn if this behaviour pattern has been reported elsewhere.

TEA RESEARCH ASSOCIATION,
TOCKLAI EXPERIMENTAL STATION,
JORHAT 8,
July 25, 1974.

J. TESSIER-YANDELL

8. NOMENCLATURE OF THE ASIAN PALM SWIFT
(*With a plate*)

Brooke (1972) has given reasons for separating the African Palm Swift *Cypsiurus parvus* (Lichtenstein) from the Asian, which he designated by the name *Cypsiurus batasiensis*. Although aware that the original spelling of the species-name was *balasiensis*, Brooke (op. cit., p. 219) considered that "sound nomenclature is best served" by retaining this emendation, which was originally proposed by Baker (1927, p. 336).

The name *balasiensis* was first published by J. E. Gray in Griffith & Pidgeon (1829, p. 60), as the following brief entry:

Balasian Swift. Lath. *Cyp. Balasiensis*

Dull brown, with the outer toe versatile. India.

The indicated authority for the English name is John Latham, who described the bird in greater detail under the title 'Balassian Swift' (Latham 1823, pp. 329-330). Because of its general interest and relevance to the argument that follows, Latham's entry is reproduced in facsimile (*see* plate).

The first named of Latham's two sources is certainly Francis Buchanan (who adopted the name Hamilton in later life), a medical officer in the service of the East India Company from 1794-1815 (Stephen & Lee 1908). Dr Buchanan (Hamilton) was a naturalist of wide interests. His published works included reports of travels in parts of India and Nepal, and a treatise on the fish of the Brahmaputra. It is apparent that he also wrote an unpublished manuscript on Indian birds. Such a manuscript was undoubtedly available to Horsfield & Moore, in whose catalogue (1854, p. 108), Dr. F. (B.) Hamilton is cited as the source of the vernacular names for the Palm Swift ('*Putta-Deuli*, Hind., *Batassia*, Beng., and *Ababil*, of the Mussulmans'), and also as the author of 'MS. I, p. 82', quoted as follows:

> This bird inhabits Bengal at all seasons, and is a nocturnal bird, appearing at sunset and going to rest at sunrise. It builds its nest in the fronds of the TAL (*Borassus flabelliformes* Linn.). The Bengalese name signifies a bird resembling wind, and is bestowed on account of its swift flight.

The similarity between the phraseology of this passage and the sentences in Latham's (1823) account is sufficiently marked to establish that the author was indeed the same man, and to suggest very strongly that the compilers in both cases had before them the same document.

'There can be little doubt that the common source consulted by these authors was an untitled manuscript describing animals and birds at Barrackpore, now in the India Office Library, registered no. MSS Eur. D. 541. The second volume of this work (reg. no. MSS Eur. D. 94) forms part of the Buchanan-Hamilton Collections, and it is reason-

able to assume that the Doctor was the author of both. Pages 82-83 of the first volume are devoted to the palm swift. Since this description is evidently an important primary source, it is transcribed in full below:

Hirundo Apus Batassia B
Abavir of the Musulmans.
Batassia of the Bengalese.
Putta deuli of Hindustan proper.

The Bengalese name signifies a Bird resembling wind, and is bestowed on this species, on account of its swift flying. It inhabits Bengal at all seasons, and is a nocturnal bird, appearing at sun set, and going to rest at sun rise. It builds in the folds of the leaves of the Tal, or *Borassus flabelliformis* Linn.: The length from the point of the bill to the end of the tail is four inches and six tenths. The wings, when shut, are two tenths of an inch longer than the tail; and, when opened, extend ten inches. The tail is two inches and three quarters in length. The toes reach very little beyond its root. The bill is very short, and much depressed, sharp, and rather incurved at the point. The nostrils are oblong, and naked. The feathers of the frontlet are reversed. The irides are brown. The crown, neck, and back are brownish. All the under parts, sides, rump, upper tail coverts, and the wing coverts next the body are ash-coloured. The wing coverts most remote from the body, and the under wing coverts are dusky. The wings are very much acuminated, the secondary quills being very short. The quills are sharp pointed, black on the upper side, and dusky beneath. The tail is much bifurcated, and consists of ten acuminated feathers, dusky above, and tsh coloured beneath. The legs above are feathered to the toes, and behind are naked. The toes are black and four in number, two turned to one side, and two to another. The claws are as long as the toes, and are much hooked.

The history of these has been discussed in detail by Dawson (1946). On the General's death, his collection passed to the British Museum, and the illustrations of biological interest, sorted into systematic order, mounted and bound, are now divided between the Botanical and Zoological libraries of the British Museum (Natural History). The pictures numbered 114-116 in Volume VI (catalogue no. 10979) show adult and juvenile palm swifts, and a nest, attached to a palm frond, containing three young. These drawings are the originals (copied carefully, but appearing as mirror images in the publication) of the representations grouped in Plate 35 of Gray & Hardwicke's Illustrations of Indian zoology', part 2, where they are named 'Balassian Swift *Cypselus palmarum* n.'. In the original drawings, the adult male is localised and dated 'Cawnpore June 1800'.

Griffith & Pidgeon's translation of Cuvier, in which Gray's name *balasiensis* appeared, is dated 1829 on the title page. The plates are also individually inscribed with the dates on which each was made. The latest plates are dated October 1829, showing that the completed book must have appeared at the very end of that year. Part 2 of the 'ILLUSTRATIONS OF INDIAN ZOOLOGY, containing the name *Cypselus palmarum*,

66.—BALASSIAN SWIFT.

LENGTH between four and five inches, breadth ten. Bill short, incurved at the point, and much depressed; nostrils oblong, dusky; irides brown; plumage above ash-coloured, not unlike that of the Sand Martin; beneath paler; quills sharp-pointed, black above, dusky beneath; the wings much acuminated, the second quills being very short, and for the most part dusky; tail much bifurcated, consisting of ten feathers, in colour like the quills; in length two inches and three quarters; the latter, when closed, are a trifle longer than the tail; legs feathered before to the toes, which are four in number, two turned on one side, and two on the other, claws long, and the toes much hooked, and reach very little beyond the root of the tail.

Inhabits India: is the Abavir of the Mussulmans; Balassia of the Bengalese; and Putta deuli of Hindustan Proper. The Bengalese name signifies a bird resembling wind, and is bestowed on this species, on account of its swift flight. Found at Bengal at all seasons; is a nocturnal bird, appearing at sun-set, and going to rest at sun-rise. It builds in the folds of the leaves of the Tol, or Borassns flabelliformis of Linnæus.—Dr. Buchanan.

This is figured in General Hardwicke's drawings, dated Cawnpore, June, 1800; length five inches.—A male.

Facsimile of Latham's description (from Latham J. A GENERAL HISTORY OF BIRDS 7, 1823).

was published in March 1830 (Kinnear 1925). Gray thus published, within a few months, two names for the same species, both based (in the one case directly, and in the other case indirectly through reference to Latham's work) on the same set of drawings of specimens from Cawnpore (i.e., Kanpur) made in 1800.

T. C. Jerdon (1840), following Gray (1830), referred to the species as the Balassian Swift *Cypselus palmarum*. Shortly thereafter, the priority of *balasiensis* was recognised. G. R. Gray (youngest brother of J. E. Gray) in 1844 (p. 54) gave *Cypselus balasiensis* as the valid name, with *Cypselus palmarum* as a synonym. Blyth (1849, p. 86) also used the name *Cypselus balasiensis* for this swift, listing *C. palmarum* in synonymy.

The first emendation of the spelling was introduced by Horsefield & Moore (1854, p. 108) who called this bird *Cypselus batassiensis,* adding a footnote: *Balassiensis, Auct. corrigend.* The 'corrected' name *batassiensis* was subsequently in general use in ornithological literature for several decades; see, for instance, Jerdon (1862), Sclater (1865), Blyth (1866), Holdsworth (1872) Blanford (1895).

A second modification was proposed by Baker (1927, p. 336), who evidently made only superficial research of the problem, writing:

> The name of this little swift was first written *balasiensis* but the name is derived from the Bengali name *batassia* and is obviously a misprint and the amended name *batasiensis* must be accepted.
>
> Gray, in using the Bengali name, may be inferred to have applied it to the Bengali bird and the type-locality can therefore be restricted to Calcutta, thus leaving the name *palmarum* free for the paler Western form depicted in Hardwicke's Illustr. of Ind. Zool.

Peters (1940, p. 256) reverted to Gray's original spelling, listing the Indian population of palm swift as *Cypsiurus parvus balasiensis.* Despite this lead from a careful taxonomist, Baker's emendation has continued to be used in various combinations by most authors including recently, Ripley (1961) and Ali & Ripley (1970).

Conclusion

J. E. Gray's original description, although brief, satisfies provisions (a), (b), (c) and (g) of Article 11, and Article 12 of the International Code of Zoological Nomenclature. Moreover, the consistency of English and Latin names is evidence that Gray's spelling of *balasiensis* was deliberate, and not a copyist's or printer's error. By Article 32 (a) (ii), this spelling is therefore to be retained. Emendation is not justified because Gray chose to use a single 's', nor because his indicated source (Latham 1823) apparently misread or wrongly or carelessly transcribed the Bengali name according to Buchanan.

The name *palmarum*, published a little later, was recognised by contemporaries to be a synonym. As shown above, the documentary evidence does not support Baker's (1927) argument for selecting Calcutta as the type locality, and it is probale that his restriction should be corrected (International Code: Recommendation 72E). Fortunately Whistler & Kinnear (1935) and Brooke (1972) have in independent contributions rejected the separation of eastern and western races on morphological grounds, and consequently the problem of subspecific nomenclature does not arise. Following Brooke's (1972) definition of the species, and taking distributions from Ali & Ripley (1970), the palm swift occurring through most of India is evidently correctly known as *Cypsiurus balasiensis balasiensis*, and the South-east Asian race which apparently reaches Assam is *C. balasiensis infumatus*.

ACKNOWLEDGEMENTS

I am grateful to Mrs A. Datta of the Library, British Museum (Natural History), and to Dr R. J. Bingle of the India Office Library and Records, for their assistance in tracking down Buchanan-Hamilton's manuscript. All other sources were consulted in the libraries of the British Museum (Natural History) or the Zoological Society of London, and it is a pleasure to acknowledge the kind cooperation of staff of both institutes.

GREAT GLEMHAM HOUSE,
SAXMUNDHAM, SUFFOLK,
UNITED KINGDOM,
May 11, 1973.

LORD MEDWAY

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9. THE BLUECHEEKED BEE-EATER *MEROPS SUPERCILIOSUS*, ITS STATUS IN KUTCH AND SAURASHTRA

The Durbar Saheb of Jasdan and myself had the pleasure of visiting the Flamingo City in the Great Rann of Kutch and some of the Bets beyond towards the border of Sind. We saw a party of about six of these large bee-eaters at Nir on 9th June. On the 11th on our return from the Flamingo City we rested during the heat of the day at Nir before going on to the Bets and after imbibing several glasses of lime juice we strolled around the water course. All the time we heard the bee-eaters calling as they sailed around. Following the winding nullah we came across a ten foot high embankment riddled with bee-eater holes, all large and fresh. There were some eighty such holes and by their size we surmised them to belong to *M. superciliosus* and their appearance suggested that they had been in recent habitation. The presence of the birds in the area confirmed our surmise. Later we again saw these fine bee-eaters on Kuar Bet. They were in magnificently fresh plumage. Sálim Ali, in both his BIRDS OF KUTCH and the 'Birds of Gujarat' (*J. Bombay nat. Hist. Soc. 52*:2 & 3) mentions it as an autumn passage migrant. It may be noted that in the HANDBOOK OF BIRDS OF INDIA AND PAKISTAN Volume 4, Ali & Ripley mention Dharmakumarsinhji's report of the species regularly breeding on the Bhavnagar coast, where incidently it is a regular breeding bird and I myself have seen them

around the aerodrome in August. I might mention here that one of my earliest memories of this fine bird is as a boy when I watched at close range three pairs excavating nest holes near Jasdan. This year I have heard them over Rajkot in late May and they have been heard at Jasdan and so they must have been breeding in the area, or possibly passing onto their breeding location near Bhavnagar.

14, Jayant Society, LAVKUMAR J. KHACHER
Rajkot 360 004,
June 16, 1974.

10. A DAY AT A NEST OF THE GREAT BLACK WOODPECKER (*DRYOCOPUS JAVENSIS*)

(*With two plates*)

On a five-day visit to the Periyar Wild Life Sanctuary during the second week of January, 1974, I concentrated on a search for the Great Black Woodpecker which had so far eluded me. On the second day I ran into Mr Robert Horwich, an American researcher on primate behaviour, who said that he had seen a Black Woodpecker almost at that very spot earlier in the morning. Still, in spite of spending three more days at Thekkady I had to leave without so much as a glimpse of the Black Woodpecker.

About a fortnight later Mr Nanu Nair, Wild Life Preservation Officer, Thekkady, informed me that Mr Horwich had found an occupied nest of the Black Woodpecker close to the Picnic Spot. So, at 17.45 hrs on the 2nd of February I was back at the place where Mr Horwich and I had first met on 12-i-1974. There Mr Nanu Nair pointed out a giant tree, quite dead and devoid of all bark, just 20 feet away. At a height of *c.* 20 m and very near the top was the woodpecker's nest, with the female peeping out. It was on the southern side of the tree, just below a large, shallow, irregular cavity. We were to discover the next day that almost all day the sun fell directly on the nest.

The tree stood in the midst of a good stand of medium sized deciduous trees and dense, thorny underground on a narrow strip of land between the road and an arm of the lake. Hardly a stone's throw from the road, it was exposed to all the noises of busy traffic, loud talk and other evidences of flourishing tourism.

That evening we were able to watch the nest for 55 minutes only (1745 to 1840 hrs). At 1805 hrs the male came and alighted on a tree trunk *c.* 10 m ESE of the nest. While hopping up he uttered a few very low *quack* notes. The moment the male alighted on the nest tree, the female flew out with a smooth glide, quite noiselessly. The male entered the nest at 1807 hrs after thrusting his bill smartly 3 or 4 times into

the cavity. Almost all the time between 1807 and 1840 hrs he was looking out of the nest. A minute after he had got in, a pair of Hill Mynas (*Gracula religiosa*) alighted on the horizontal branch below the nest and went on calling. They then flew to a tree close by, and one of them was seen flying into some hollow on the northern side of the woodpeckers' tree. The mynas never approached the woodpeckers' nest and the woodpecker seemd to ignore them. Mr Horwich, however, said that on some days he had seen Hill Mynas going to the woodpeckers' nest and being chased away by the woodpecker.

On 3-ii-1974 I watched the nest for a total of 8 hours and 15 minutes (0750 to 1300, 1500 to 1700, and 1740 to 1845 hrs). Mr Horwich who had kindly agreed to take photographs for me was with me all forenoon and again during the last session (with Mr Nanu Nair as well). The photogrphs were taken with a Nikkormat camera and a 400 mm telephoto lens.

A brief account of what I saw during the day follows:

0750 to 0915: Nest appeared to be unoccupied, but in fact the female was in.

0915—7 to 8 dull taps (low *dok-dok-dok*) from the east, repeated 3 times. Two minutes later the male came from the east and alighted on the trunk of a tree east of the nest tree. At 0921 he flew to the nest tree alighting 6 feet below the hole and began hopping up. The moment he had alighted on the nest tree, the female thrust her head out, uttered a number of *'chyank's'* in quick succession and at 0923 flew off to the east. The male entered and remained till 1235 hrs.

At 1220 came a series of dull taps from inside the nest, 5 to 8 taps at a time, repeated thrice. This was followed by a rapid series of dull du-du-du-du notes (drumming?).

At 1230 hrs the female alighted on the trunk of a teak NW of the nest tree and began hopping up quite silently. She then uttered a number of low *quacks* to which the male replied with feebler notes. She flew to the nest tree at 1235, alighting just below the nest. The male flew off at once and his place was taken by the female.

The nest was not watched between 1300 and 1500 hrs. At 1500 hrs the female was in the nest, peeping out. Ten minutes later she withdrew her head. At 1520 she began looking around and withdrew into the hole only at 1534. The male came from the south at 1550 to a tree SSE of the nest. Simultaneously the female peeped out. To a few low *chyup* notes of the male the female responded with a few dull taps on the wall of the nest. The male flew to the nest tree and the female flew off at once. He went into the nest and turned a somersault so that his head appeared where his 'forked' tail had been a moment ago.

At 1608 a flock of 4 or 5 Hills Mynas flew past the woodpecker tree, landed on another 11 m away and went on uttering an amazing

variety of calls. The woodpecker did not react to all this, but he seemed to look around nervously when some Bluewinged Parakeets flew past with their harsh calls, when a dog barked and again when someone banged lustily on a wooden picnic table.

The male woodpecker began to produce a series of dull taps from within and then peeped out, looking in all directions. He repeated this a number of times during the next two minutes, each series of taps being louder and more rapid than the preceding. Between 1635 and 1638 he not only played a tattoo on the inner wall, but seemed to throw something out with smart flicks of the bill after a spell of tapping. At 1638 the hammering became louder though the rate was lower. The last series of taps, a rapid *chug-chug-chug-chug* was at 1639, after which for 20 minutes, he was inactive.

From 1700 to 1740 hrs we were away and on our return found the male looking out and a Hill Myna calling loudly from the branch below the nest. At 1743 the myna left. The female woodpecker arrived at 1753, flying from the south straight to the nest tree. As she began hopping up, the male beat a tattoo of dull taps from within and then flew off to the south. The female entered the nest and remained hidden within till 1802 hrs when a pair of Hill Mynas alighted on the branch below the nest. Even then the female woodpecker did not peep out. Five minutes later one of the mynas flew to the top of the tree from where it uttered various screeches, whistles and croaks. At 1813, before we knew what was happening, the female woodpecker had come out and was chasing the mynas. She pursued them from tree to tree without uttering any call notes and, quite as suddenly as she had come out, went into her nest leaving the mynas on two different trees. The mynas went on calling loudly.

At 1814 hrs a loud but dull drumming came from the east. The mynas returned to the branch below the nest and were very noisy. A couple of Southern Tree Pies had appeared meanwhile and were contributing their mite to the clamour.

At 1822 hrs the woodpecker shot out of the nest and again drove the mynas away. After chasing them around for a minute, she returned and went straight into the nest. One of the mynas flew at 1825 into the hollow on the nest tree into which a myna had gone the previous day. The other myna went on calling from a tree close to the nest. At 1828 the appearance of the female woodpecker's head at the nest entrance coincided with a loud drumming from the east. The second myna also disappeared into the hollow behind the nest at 1830. Just then the male woodpecker alighted on a tree SE of the nest (these woodpeckers did not seem to have a definite 'route' to the nest) and male and female held a duet of low *chiank-chiank-chiank* notes. Uttering the same low sounds, the male flew to the nest tree at 1837, his arrival

The nest tree.
(*Photo*: *Robert Horwich*)

Neelakantan: Nest of the Black Woodpecker

coinciding with the female's departure to the south. The male dipped his head five times into the nest, entered, reversed, and began peeping out. By 1845 it was dark. I left the spot at 1900 hrs and left Thekkady early the next morning wondering whether I could afford to go again to see the young being fed.

General remarks

1. The male presumably spent the night in the nest on both days. Though no evidence could be adduced, the fact that the birds never left the nest unoccupied and remained within for periods of roughly 3 hours at a time during the day suggested that there were eggs in the nest. If the presumption is correct, we may conclude that both male and female incubate the eggs. (*See* Sálim Ali & Ripley: HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, Vol. 4, p. 209).
2. The HANDBOOK (same page) says, "Very sensitive to disturbance by humans, soon forsaking localities where lumbering is in progress or the forest has been felled." This pair, at any rate, seem to have gone out of their way to select a spot where human activity and noises were no less than at a lumbering camp. Did the atttractions of the dead tree outweigh the drawbacks of the place where it stood?
3. On the 2 days when we observed them the birds were remarkably unobtrusive. They never uttered any loud calls and their wings too did not produce the rattling sound often heard when the goldenbacked woodpeckers fly. The movements of these large woodpeckers were so quick and quiet that only chance could have betrayed their presence. In coming and going they preferred to fly quite a distance through the thickest part of the wood before crossing open ground. That the brooding sessions were often 3 hours long also helped to prevent their being noticed in the neighbourhood of the nest.
4. Between 1745 on 2-ii-1974 and 1900 on 3-ii-1974 the change-over at the nest was observed six times. It was not accompanied by any elaborate display. Towards the close of a brooding session, the bird in the nest tapped on the nest wall. This could have been a sign of impatience or a summons to the mate (though whether the tapping could have been heard by the mate unless it were close by is very doubtful).

Postscript

A few days after my return to Trivandrum I heard from Mr Nanu Nair that Mr Horwich feared that the woodpeckers had deserted. Curiously enough it looked as though the mynas did not take over the cavity. Why then did the mynas come to the nest tree, and why did the woodpecker resent their visits? It is not improbable that the mynas were using the hollow on the northern side of the tree to roost in and

that their visits were only at roosting time. Their noise could have got on the nerves of the female woodpecker and made her try to shoo them off. If the mynas had been planning to usurp the nest, they should have paid some visits earlier in the day as well. Also, they would certainly have taken possession of the cavity as soon as the woodpeckers had left.

The photographs illustrating this note were taken by Mr Robert Horwich at my request. I am grately obliged to him for sparing the time taken up by the photography as well as for his company. To Mr K. Nanu Nair, Wild Life Preservation Officer, Thekkady, my idebtedness is even greater, for without his enthusiastic co-operation I would not have heard of this nest or watched it in such comfort and style. I am also grateful to Mr D. Vaidyanath, Photographer, Trivandrum Museum, for processing the negatives and printing the photos.

UNIVERSITY COLLEGE, K. K. NEELAKANTAN
TRIVANDRUM,
May 6, 1974.

11. ON THE OCCURRENCE OF *LANIUS EXCUBITOR AUCHERI* BONAPARTE IN PUNJAB

Stuart Baker (FAUNA *2*:288) said that *Lanius excubitor aucheri* Bonaparte extended in winter into the plains of the Punjab and NW. Frontier Province, but Ali & Ripley (1972, IND. HANDBOOK *5*:82) restrict it as a winter visitor to N. Baluchistan and central and coastal Makran.

In 1941, in 'The Birds of Bahawalpur (Punjab)' (*J. Bombay nat. Hist. Soc. 42*:717) Sálim Ali referred to a ♀ grey shrike collected in Bahawalpur town environs on 29 January 1939 and named it *Lanius excubitor lahtora* (Sykes). Upon re-examination I make this *aucheri*, which identification is confirmed by Mr Bond at Smithsonian Institute.

75, ABDUL REHMAN STREET, HUMAYUN ABDULALI
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July 31, 1974.

12. CHANGE OF IRIS COLOUR DURING THE POST-FLEDGING PERIOD IN THE COMMON BABBLER (*TURDOIDES CAUDATUS*)

INTRODUCTION

During the course of ringing operations in an area of mixed *Prosopis*/*Acacia* woodland and *Zizyphus* scrub adjacent to New Delhi notes were kept on the colour of the iris and the state of moult among Com-

mon Babblers. During the period between fledging, and the completion of the post-juvenile moult Common Babblers were found to undergo two changes of iris colour, and at close range these enable birds to be aged in the field up until four or five months old.

Methods

About 200 Common Babblers were trapped between August-November 1971, and between July-November 1972, of which 70 were birds in their first year which had not yet completed their post-juvenal moult. Juvenile birds could be identified by the blunt, rounded tips to their primaries, particularly the 10th, as mentioned by Naik & Andrews (1966) for the Jungle Babbler (*Turdoides striatus*).

The state of moult was recorded for each bird according to the system used by Newton (1966), where each new or growing primary feather is assigned a rank score from 0 (feather missing) to 5 (growth complete). Secondary moult was scored in the same way, and the state of moult in the retrices, wing coverts, and body tracts was noted in general terms. The colour of the iris was also noted.

During 1972 a number of nestlings were ringed, and six of these were retrapped during the post-juvenal moult. A total of 13 birds in the two seasons, were trapped two or more times during the course of their post-juvenal moult, and from these the mean rate of post-juvenal moult was calculated in points/day. This rate was then used to calculate a date of commencement for the post-juvenal moult of the six birds ringed as nestlings, and hence find the mean length of time between fledging and the onset of post-juvenal moult.

Results

The course of post-juvenal moult is fairly similar to that of the adult moult, which in turn resembles that of the adult Jungle Babbler described by Naik & Andrews (1966). In contrast to the adult moult, however, the moult of the greater coverts usually begins before the onset of the primary moult, and the moult of the retrices lags behind that of the primaries so that birds are found with a complete set of adult primaries, but most, or in some cases all, of the juvenal retrices. Because of the abrasion the juvenal retrices tend to become hard to identify after a few months and do not provide much help in ageing.

The mean rate of the post-juvenal moult in points/day was found to be 0.95 (n = 13, 95% confidence limits 0.61-1.29), giving a mean length of primary moult of 105 days (95% confidence limits 77-164 days).

Using the six individuals for which the date of fledging was known, and the mean rate of primary moult, the periods between fledging and

the commencement of the primary moult were calculated as 30.5, 31.5, 36.5, 39.5, 47, and 47 days (mean = 38.7 days). Thus the mean duration of the period between fledging, and the completion of the primary moult is about 144 days.

The colour of the iris in the adult *Turdoides caudatus* was found to be invariably a dark, warm brown, sometimes with a narrow white marginal rim. No birds in juvenal plumage, or in post-junvenal moult, showed exactly this colour of iris. Table 1 shows the different categories into which irides could be classified, and the number of birds at each stage of post-juvenal moult recorded in each class.

TABLE 1

RELATIONSHIP OF IRIS COLOUR TO PRIMARY SCORE DURING POST-JUVENAL MOULT

Iris colour	Number of individuals trapped in each moult score category						
	0	1-19	20-39	40-59	60-79	80-99	100
1. Dark grey with olive tinge (nestlings and birds with juvenal remiges not fully grown)							
2. Dark grey	4 (all moulting greater coverts)						
3. Pale hazel brown	3	12	9	12	7	4	1
4. Dark brown at centre, grading to hazel at margin				1	2	1	1
5. Dark brown with traces of hazel at the margin						2	7

The majority of birds trapped during the course of the post-juvenal primary moult (88%) showed a pale hazel iris. The coincidence of the hazel iris with the duration of the post-juvenal moult suggests that the changes in iris colour might be linked to the same hormones that initiate and control the course of the moult.

A few birds reared late in the season do not commence the post-juvenal moult until the following spring, but in these birds the juvenal iris colour is lost, and the iris changes to hazel, although the exact timing of this change was not observed. One bird, reared in early October, was still in juvenal plumage the following February, and had a hazel iris at 120 days old. Another, reared in September, showed arrested moult at P_3 when trapped in February and had a hazel iris at 150 days old.

The occurrence of the transitional stages between hazel and the adult colour in only 14 out of the 59 birds trapped in post-juvenal moult suggests that this change probably takes less than a month. The transition from the juvenal colour to hazel must be even more rapid, since transitional individuals were seen at all.

In the field a bird which has not yet started the post-juvenal moult can be easily recognised by the yellow, fleshy gape. This usually disappears soon after the onset of the post-juvenal moult, and during this period the hazel iris provides a useful guide to the age of the bird at close range, since it is much paler than the adult iris.

Discussion

Among the Indian species of the genus, the Common Babbler is the only one to have a dark iris when adult. In the Jungle Babbler (*T. striatus*), the Rufous Babbler (*T. subrufus*), the Whiteheaded Babbler (*T. affinis*), Ceylon Rufous Babbler (*T. rufescens*), Spiny Babbler (*T. nipalensis*), and the Slenderbilled Babbler (*T. longirostris*) the adult iris is white, and in the Large Grey Babbler (*T. malcolmi*) and the Striated Babbler (*T. earlei*), bright yellow (Ali, Sálim & S. D. Ripley 1971). The colour of the nestling and early juvenal iris is very dark grey throughout the genus. It would seem likely that the dark adult iris of the Common Babbler has been evolved lately, and that the pale hazel iris which appears during the post-juvenal moult represents a recapitulation of the former adult colour.

In the Arabian Babbler (*T. squamiceps*) the female iris colour is similar to that of adult Common Babbler, but the adult male iris is off-white, and similar in colour to that of the Common Babbler during post-juvenal moult. The colour of the nestling and early juvenal iris is the same as that of the rest of the genus.

The Arabian Babbler is extremely similar to the Common Babbler in general morphology, differing from it mainly in its larger size. Since the western races of the Common Babbler are larger than the eastern ones, it seems possible that the Arabian Babbler may represent the speciation of the western end of a former cline, running from peninsular India to the Near East.

In bill colour, adult male Arabian Babblers resemble first year birds of both sexes, whereas the bill changes colour in adult females, and in this respect the adult male character may be considered neotonous (A. Zahavi, pers. comm.). If this is the case then it seems likely that sexual dimorphism in the Arabian Babbler must have evolved through retention of the juvenal iris colour in the male.

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13. OCCURRENCE OF THE PURPLE COCHOA *COCHOA PURPUREA* HODGSON, NEAR MUSSOORIE, U.P.

During a recent collection trip to Mussoorie, we obtained a speimen of a male Purple Cochoa (*Cochoa purpurea* Hodgson) at Dhanaulty, *c*. 2318 m, approximately 21 km east of Mussoorie on 9th July 1974. According to Blanford & Oates (1890, FAUNA OF BRITISH INDIA *2*) and Sálim Ali & Ripley (1973, HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN *8*) the western-most limit of this species is Almora/Nainital, but Baker (1924, FAUNA OF BRITISH INDIA *2*) includes Simla within its range (approximately 114 km northwest of Mussoorie).

This specimen was one of a pair seen along with Greywinged Blackbirds [*Turdus boulboul* (Latham)], in dense undergrowth at the edge of a vast clearing on a hillside slope. Though a considerable area around the spot is cleared to bring under potato cultivation, the thick vegetation along the ravines on the lower slopes might provide this bird enough cover to breed in this area. This rare and shy bird skulks in dense patches and is seldom seen. Ripley (1950, *J. Bombay nat. Hist. Soc.* *49*: 386) presumably saw it in Bhimphedi, Nepal, where later Biswas (1961, ibid. *58*:665) collected a single male. Smythies (1950, ibid. *40*:515) mentions of a record of this species at Sheopuri, Nepal. The present specimen is the second in the Society's collection, the first was obtained by Dr. Sálim Ali at Gedu, *c*. 2000 m central Bhutan on 15th October 1968.

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14. SOME SYSTEMATIC NOTES ON THE YELLOW-BREASTED TIT (*PARUS FLAVIPECTUS*)

1. *On the Azure Tit in Chitral*

In July, 1902, H. T. Fulton collected five Azure Tits "in the dense scrub of stunted willow, juniper and birch" in a river bed at an altitude

of about 3000 m at Shost in Chitral. Though his note (1904, antea *16*) suggests that the tits were rather numerous then there is no later record of an Azure Tit in Chitral or elsewhere in Pakistan or India. Possibly, Fulton merely had met with an occasional wandering flock from the Pamirs or Afghanistan but more probably the tit bred (or still breeds) in the montane forests of Chitral.

Fulton who compared the birds with European *P. caeruleus* but not with *P.* (*cyanus*) *flavipectus* from neighbouring Turkestan concluded they were *P. cyanus tianschanicus* Menzbier. At that time, the distribution of the azure tit forms was only rather poorly known. Actually, the western limit of *tianschanicus* runs from the mountains west of Lake Issyk-kul (Kirghiz Range) through Naryn, western Kashgaria and the Tashkurgan Range to the Khalastan but more probably farther west through the Sarykol Range to Hunza where the white-breasted form (*tianschanicus*) has been found near Misgar in October (Ludlow & Kinnear 1933). Yellow-breasted tits (*flavipectus*) occur in the Pamirs eastward to about 73°E (Ivanov 1969).

Thus, one might infer that the Chitral birds belong to *flavipectus* rather than to *tianschanicus*. Stuart Baker (1922), Hellmayr (1929), Hartert & Steinbacher (1933), however, followed Fulton in considering them to be the latter form. This is doubted by Vaurie (1957, 1959) on the basis of Snow's notes who had compared three of the Chitral tits in the British Museum and found they were "far too much yellow" to be typical *tianschanicus*. Contrary to this statement, Snow later (1967, in the Check-List) includes Chitral in the range of *tianschanicus**. Vaurie (1957) concedes that hybrids may occur but thinks it "probable that the population of Chitral is *flavipectus*"—if there is one at all.

Mr. Humayun Abdulali sent me one of the two Chitral birds in the collection of the Bombay Natural History Society for examination. Through the courtesy of the authorities of the British Museum (by sending three of Fulton's skins), the Zoological Museum of the Moscow University, the Zoological Institutes in Leningrad and Halle I was able to compare four specimens from Chitral and a good number of *tianschanicus* and *flavipectus*.

A series of 15 young *flavipectus* (including *carruthersi;* mostly from Ferghana and Tadzhikistan) differs very clearly from 13 young *tianschanicus* (from northern Mongolia, eastern Tian Shan in Chinese Turkestan and southern Kazakhstan) in the tinge of the greyish upper parts: it is distinctly, sometimes even strikingly yellow in *flavipectus*, and pale bluish (fresh skins) or brown, sometimes with a faint pinkish wash (older, foxed skins) in *tianschanicus*. The Chitral birds share the yellow tinge above and below of *flavipectus* and, hence, belong to this

* There, page 117, line 17: for "Altai" read "Alai".

form (if they are closer to *flavipectus* s. str. than to *carruthersi* is discussed below). They differ, however, from either subspecies by being somewhat paler above. The Bombay specimen is less pale and differs in having a brownish rather than greenish tint on the back. This is clearly the effect of foxing; the nuchal band in some young *carruthersi* show some brown, too, and many young *tianschanicus* have a brownish wash above, most distinct in a bird collected in 1876.

The yellow of the under parts is rather pale about as in one juvenile *tianschanicus* from the eastern Tian Shan and paler than in nearly all *flavipectus* and *carruthersi* before me. In just one bird (Brit. Mus. 1904.12.5.14) it is as deep as in average *carruthersi*. This might be one of the birds believed by Fulton to be young (while he thought those with less bright yellow under parts were full-grown individuals). The material is too poor to allow a judgement if the coloration of the Chitral birds is due to individual variation, distinctness of a local (isolated) population or intergradation though the latter is not very probable. The problem has been discussed by Vaurie (1957), and there is no further evidence. It should be stated here that the birds collected by Fulton are clearly not *P. cyanus tianschanicus*.

How the breeding range of the Yellow-breasted Tit is shared among the two subspecies is still unclear. Voyinstvenski (1954), Portenko (1954) and all authors dealing with the birds of Middle Asia ignore the geographic variability within this form. Vaurie (1959) includes the populations of the Alai mountains, the (western) Pamirs and (central) Tadzhikistan in *flavipectus* whereas Stepanyan (1972) says they belong to *carruthersi*, grading into *flavipectus* in "the eastern parts of the Alai Range (specimens from Gulcha)". I did not see any material from these regions. The birds from Chitral are not helpful in this issue since they match *carruthersi* in showing less yellow above and below while they are closer to *flavipectus* in the tail pattern (5 rectrices with white spots).

The taxonomic rank of *flavipectus* (and *berezowskii*) will not be discussed here. Recently, Stepanyan (1972) has reappraised the evidence and considers *flavipectus* to be a distinct species.

2. *Description of the young*

The juvenile plumage of *carruthersi* has not yet been described. Voyinstvenski (1954) and Portenko (1954) merge this subspecies in *flavipectus* and (like Menzbier 1895) do not even describe the young of the latter, a full description of which evidently has never been published. Hartert (1905) said they are duller on the upper parts than young *tianschanicus* (which he does not describe, to be sure), with a more or less perceptible greenish wash and light sulphur-yellow below. Vaurie (1959) oversimplifies this by saying the young were "deeply

tinged with yellow throughout the entire plumage". This plumage may be described as follows:

Juvenile *flavipectus*.—(Upper parts) fore-head and stripe around crown pale yellow to yellowish white; crown and hind-neck dull grey, the crown often lighter, with a faint bluish tinge; rest of upper parts including upper tail coverts yellowish olive-grey; (sides of head) dark grey line through lores and behind eye, cheeks and ear-coverts like under parts pale to rather bright lemon-yellow; tail, primaries, secondaries, primary-coverts as adult; greater coverts dull grey with broad yellowish-white tips and some bluish on the outer webs; median and lesser coverts slate-grey.

Juvenile *carruthersi*.—Differs from the preceding in being somewhat less vividly tinged yellow on the average (in the specimens examined by me, almost throughout and independent of wear) on the back and less brightly yellow on the under parts, throughout distinctly paler than the breast of the adult. In tail pattern, same difference as in adults.

Hartert & Steinbacher (1933) claim that the juvenile *P. cyanus tianschanicus* "has a yellowish breast and, therefore, apparently has sometimes been taken for *flavipectus*". Vaurie (1959) found *tianschanicus* only "occasionally very faintly tinged with yellow below". Neither is fully correct. Of the 13 juvenile *tianschanicus* before me one shows pale though very distinct yellow colour throughout the under parts, two a slight (ochraceous-) yellowish tinge, one patchy pale yellow over most of the under side, and five a very faint yellowish wash, all these being from northern Mongolia (see Piechocki & Bolod 1972) and Chinese Turkestan; three from Kazakhstan and one from the Mongolian Altai are practically white beneath. Hellmayr (1929) mentions two or three young tits from Chinese Turkestan (Tekes valley) with a "slight suggestion of a pale yellowish prepectoral band" and two similar birds, collected by N. Zarudny in June, 1899, in the adjacent region of Jarkent (now Panfilov).

On the upper parts, young *tinanschanicus* are less blue on the back than the adult and much darker grey on the crown. They have a sooty grey nuchal band and grey lesser wing coverts; these parts are ultramarine in the adult.

3. *Some remarks about the moult*

There are very few data on the moult of the Azure and Yellow-breasted Tits. According to Voyinstvenski (1954), Portenko (1954) and Ivanov (1969) the adults have a complete postnuptial moult July to September; juvenile birds moult at the same time but are said (by Voyinstvenski) to renew only the body plumage. This latter is open to doubt since the four Chitral birds exhibit on growing primary each,

though in one wing only (nos. 5, 5 or 6 as numbered from the carpal joint), all grown to about three quarters. Possibly, the juvenile moult includes the renewal of some distal primaries (see Stresemann 1966, p. 425).

Among the young Yellow-breasted Tits I found some in body moult. Apparently, the flank feathers are the first to be replaced (in one bird as early as June 14, while one from July 22 shows no sign of moult). This is followed by the cheeks and the lower back and rump. About at the same time, the ultramarine lesser wing coverts appear (4 specimens obtained between July 29 and August 7). A bird collected August 18 near Lake Iskander-kul shows that the feathers of the pectoral band are moulted prior to those of belly and lower breast centre. In this bird the greater (secondary) coverts are growing while the back centre is still greenish grey.

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BERLIN,
September 24, 1973.

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15. OCCURRENCE OF REDTHROATED PIPIT *ANTHUS CERVINUS* (PALLAS) IN BHAVNAGAR

On 8 April 1973 I saw a pair of redthroated pipit *Anthus cervinus* (Pallas) feeding beside Gaurishankar Lake in Bhavnagar, Gujarat. The presence of cinnamon colour on throat and breast make the identification unmistakable and separates it from the closely related *Anthus roseatus*. There was no pinkish or vinous tinge. One of the birds had a brighter throat and upper breast. Subsequently, I saw more of this species.

So far this species has been known from Gujarat only through a single record from Baroda (Sálim Ali, 1955, *J. Bombay nat. Hist. Soc.* *52*:777) and hence the present record is of interest.

DIL BAHAR, R. S. DHARMAKUMARSINHJI
BHAVNAGAR,
April 9, 1974.

16. REFLECTED GLOW FROM THE EYES OF THE GHARIAL

Abdulali (1957)[1] reported that the eyes of the Gharial (*Gavialis gangeticus*) do not reflect torch-light as do the eyes of the marsh crocodile (*Crocodylus palustris*). Oliver (Abdulali 1957) states that the eyes of the Gharial do reflect light, but not in the same fashion as other crocodilians as the "colour is a much fainter glow", and that "there was only a small area in which light could be reflected".

Recently, with the help of Mr. Romulus Whitaker, I examined six Gharial in the collection of the Sri Chamarajendra Zoological Gardens, Mysore, Karnataka. These included five young adults of unknown sex, and a female of one metre. During the course of the examination torch-light was shone at the eyes of the Gharial, at night, and the reflected glow was found to be of the same colour and brightness as that of other crocodilians. However it was observed that the area capable of reflecting light was much larger than in other crocodilians owing to the protruding nature of the eyes.

It was found that to perceive the reflected glow that the torch had to be held at eye level, and that the eyes would not reflect light from a distance of less than four metres. This has also been observed for other species of crocodilians.

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[1] ABDULALI, HUMAYUN (1957): Reflected Glow from the Eyes of the Gharial [*Gavialus gangeticus* (Gmelin)]. *J. Bombay nat. Hist. Soc.* *54*(3):769-770.

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CONSERVATION CENTRE,
GUINDY DEER SANCTUARY,
MADRAS 22, TAMIL NADU,
July 19, 1974.

CHARLES A. ROSS

17. SOME NOTES ON GHARIAL [*GAVIALIS GANGETICUS* (GMELIN)] IN CAPTIVITY

(*With a plate*)

In view of the very limited information available regarding the food and habits of the Gharial [*Gavialis gangeticus* (Gmelin)] the following notes on captive specimens in Nandankanan Biological Park, Orissa, may be of interest.

Since 1963, sixteen baby gharials have been received, 1 in March, 2 each in June, July and October, and 3 each in August, September and November. All were accidentally captured in fishing nets in the river during floods.

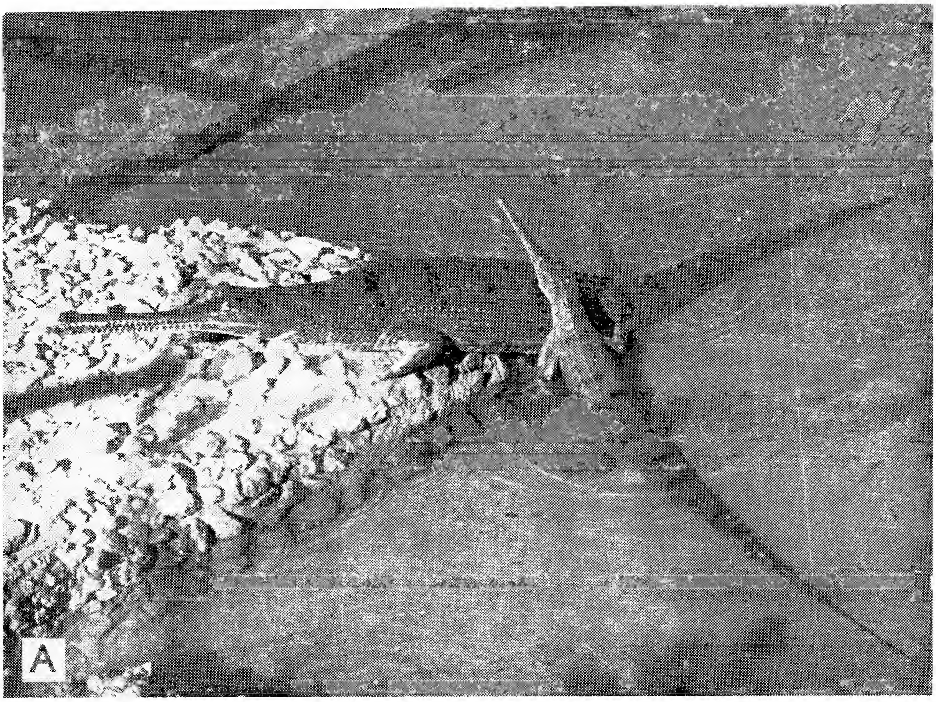
At present three gharials (1♂ 2.56 metres; 2♀♀ 2.45 and 2.48 metres) and two crocodiles [*C. palustris* Lesson (one 3 metre and the other 2 metre)] are kept together in an artificial cement tank of water with irregular sides, of an area of about 750 square feet and a depth of about 3½ feet. The shore is sandy in places and covered with laterite stones in others. The water is changed two or three times every month.

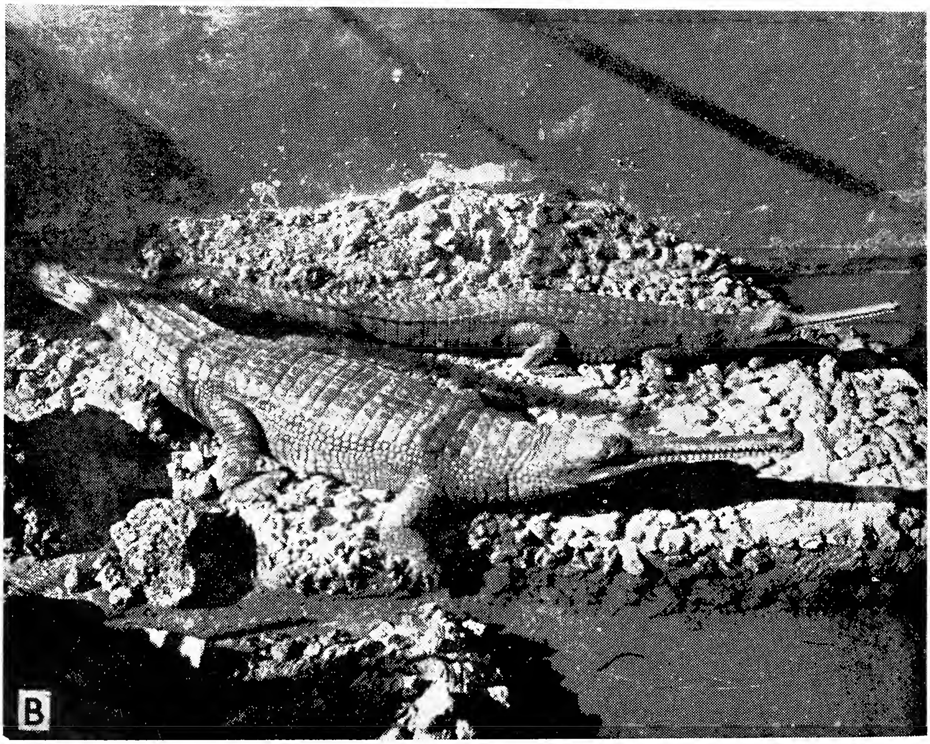
About 20 kgs of live fish, mostly *Channa gachua* (Ham.), *Channa marulius* (Ham.), *Channa punctatus* (Bloch), *Channa striatus* (Bloch), *Heteropneustes fossilis* (Bloch), *Clarias batrachus* (Linn.) *Notopterus notopterus* (Pallas), are dropped into the pond once a week, usually in the evening. The replenishment is guided by the number left and determined at the time of clearing the tank. The surviving fish suggest that *Heteropneustes fossilis* and *Anabas testudineus* are least favoured. Generally dead fish are ignored.

Once the bigger crocodile jumped out of water and caught a monkey sitting on a branch overhanging the tank.

The gharial catches a swimming fish across the middle, raises its entire snout above the surface of the water and then with 2 or 3 snaps turns the fish, bringing it deeper into the mouth and gulps its head first. These jerks of floating gharial often synchronise with a similar movement of the tail outside the water. Fish fingerlings were fed to the gharials when first received and the size increased in proportion with the growth of the gharials.

A baby gharial weighing about 600 gm and measuring about 70 cm





A. Two gharials are just coming out of water. The black bars on the body are clearly visible.

B. Same gharials are returning to water after staying sometime on the land. The black bars on the body have almost disappeared.

was released into the tank on 15th August 1970 and immediately swallowed by one of the crocodiles. Though care had to be taken with the young animals, grown-up gharials and crocodiles lived peacefully together in the same tank. Three turtles [*Lissemys punctata granosa* (Schoepff)] also lived in the same tank for several years being unharmed by the gharials or crocodiles and helped to clean the tank of dead fish and other material.

If not disturbed by visitors, the saurians in winter spent most of the day basking in the sun on the sand. They were also seen out of water sometimes on winter nights.

During summer, they left the tank for some time early in the morning and late in the evening and during the hottest part of the day remained submerged in water.

At times a sort of hissing sound was produced in the process of exhalation.

The specimens have become very tame and can be approached and examined at close quarters.

At 8 a.m. on 31st January 1974, the larger of the two females was resting on the border of the cemented tank with the front portion of the body outside the water. During one hour of observation, the male approached this female three times. He first rubbed his snout and body on her body. On the second occasion he placed his snout over her body, rested for some time and then went away. The third time he placed himself over the body of the female with his snout reaching over her head. It was also observed that the male often followed this female in water, while the other rested quietly on the sand. This was presumably sex play and may well be the commencement of the season for Prashad (1914) found matured eggs in the oviduct in March, and local evidence indicates that they lay in April, May and June.

On the same day (31st January 1974), we approached one of the female gharials lying outside the water. Until we were two metres away, there was no response, but it then opened its eyes for a moment and then closed them again probably because it did not suspect any danger. A female resting at the angle of the tank suddenly jumped into the water on hearing a bus passing at a distance of about 6 metres.

Coloration: The general colour of a fully-grown gharial when out of water is olive of various shades, the head and snout being darker. Numerous indistinct black spots are scattered over the body. When it is swimming in the water, the black spots *expand or disperse* and form 8 or 9 distinct wide black bands across the dorsal surface of the body (Pl., A). When in water, these bands appear more prominent due to the refractive index of the water but gradually disappear when it comes out of the water to the sun (Pl., B). This is due to the contraction of black pigment in the melanophores. The colour of the ventral side also

varies from greenish-olive to yellow-white and this change of colour may be influenced by temperature and sunlight.

When cleaning the tank, a number of teeth of both gharials and crocodiles were found, mostly of the former. Empty spaces in the jaws and growing teeth of varying sizes were observed in the open mouths of the gharials at close quarters. It would appear that the teeth are periodically shed and regrown, one or two at a time. Its teeth are also longer, narrower and more pointed at the tip than those of the crocodile. Those of the crocodile can be easily distinguished by their stoutness, shortness, and the greater number of striations thereon.

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WILDLIFE CONSERVATION OFFICER, R. MISRA
ORISSA, OLD SECRETARIATE BLDGS.,
CUTTACK 1,
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18. HEMIPENAL STRUCTURE IN *ELAPHE RADIATA* SCHLEGEL WITH A DIAGNOSTIC KEY BASED ON HEMIPENIS

The structure of the hemipenis is poorly known in most of the Indian species of snakes and the available information is from M. A. Smith, (1935, *Fauna. Brit. India,* Vol. III); who has himself pointed out '...descriptions considerably vary in pattern and need revision' (op. cit. p. 11). Structure as a systematic tool has been first utilised by Cope, E. D. (1893) whose classification was later modified by Dunn, F. R. (1928) but most comprehensive account of the structure is of Dowling, H. G. & Savage, J. M. (1960). An attempt has been made in this paper to prepare a diagnostic key on the basis of Smith (op. cit.) and certain observations on lepidosis variation in relation to the structure.

Hemipenis in **Elaphe radiata** Schlegel

Hemipenis extends to 24th caudal plate and the spinose area is nearly ¾th of the organ. Spines are of three types: (i) distal spines, 3-4 mm long, pointed with shallow canialiculate depressions and arranged 5-7 each in 9-10 quite distinct horizontal rows; (ii) medial spines, 5-7 mm long with blunt somewhat curved and each having a fairly marked spatulate canal (larger ones around the sulcus); (iii) proximal

spines, 2-3 mm long, pointed and arranged 5-7 each in horizontal rows.

Above description based on the specimens from north India show variation from the description of Smith (op. cit.) in that the hemipenal structure extends to 24th caudal plate and not up to 10th plate.

Diagnostic Key

Hemipenis extending upto:

1. Upto 8th caudal plate
   Spines short pointed and throughout
   Proximals few large ones .... *E. porphyracea*
2. Upto 9th caudal plate
   Spines pointed hard and not throughout
   Proximals all large
   i) a loreal .... *E. prasina*
   ii) no loreal .... *E. frenata*
3. Upto 10th caudal plate (upto 24th plate)
   Var. I Calyses deeply scalloped
   Spinose area extensive, rows horizontal
   Proximals short pointed .... *E. radiata*
   Var. II Other characters same upto 24th caudal plate .... *E. radiata*
   Calyses calyculate at tip spinose area
   extensive, rows longitudial
   Proximals few large ones .... *E. leonardi*
4. Upto 13th caudal plate
   Calyses small pointed
   spinose area relatively small (at distal $\frac{1}{2}$)
   rows longitudinal with abrupt transition .... *E. hodgsoni*
5. Upto 14th caudal plate
   i) Cups deeply scalloped spinose area half,
   calyses calyculate distal spines few, proximals in
   2 small rows (with papilla like process) .... *E. mandarina*
   ii) No cups
   spinose area more than half, calyses
   small uniform, proximals few large .... *E. flavolineata*
   Spinose area half or less (other characters same) .... *E. helena*
6. Upto 17th caudal plate
   Calyses deeply scalloped
   spines blunt, proximals short stout .... *E. cantoris*
7. Upto 21st caudal plate
   Calyses not scalloped but large thick,
   spinose area short, spines few very large
   Proximals short more in numbers .... *E. oxycephala*
8. Upto 27th caudal plate
   Other characters same as in S. No. 5 .... *E. taenura*
9. Upto 28th caudal plate
   Calyses small and scalloped,
   spinose area wide, spines uniform .... *E. mollendorffi*

The significance of the structure in diagnosis appears quite clear. Of the 14 species distributed over India, Burma, Sri Lanka, Pakistan,

Indo-Chinese and Malayan regions, the closest resemblance is between *E. prasina* and *E. frenata* in the orientation of the hemipenal structure. This may be due to closer affinity as also nearly overlapping distribution. There also appears a relation in distribution and length of the structure. Himalayan species (*E. prophyracea, E. prasina, E. frenata, E. radiata, E. flavolineata* and *E. cantoris*) comprise one group having structure from 8 to 17 (24 in a var.) caudal scutes. In the group of species distributed in western Himalayas, the hemipenal length is upto 13 to 14 caudal scute; while in species of eastern Himalayas the length of the structure is shorter—with the exception of *E. radiata* which has a overlapping distribution (Bhatnagar 1969). Within Chinese species the aspect deserves further study as neither clear descriptions nor good material is available for study. Within Burmese and Malayan species we find that shorter penis length character repeats but there is a upward trend. However, only a large series of specimens can elucidate the character correctly. Similar situation appears to be within Indo-Chinese species and deserves study in large series.

Himalayan species show a close range of maxillary teeth numbers; number of costals with exception amongst *E. hodgsoni* and *E. cantoris;* ventral scute count variation is 190-236; caudal scute variation from 52-145 and labial count variation appears negligible.

It thus appears that systematic studies on Indian Ophidians deserve a closer study particularly in light of hemipenis character and correlation with lepidosis with distribution. The aspect appears so far neglected.

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NEW DELHI 110 008,
July 16, 1973.

R. K. BHATNAGAR

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19. *ECHIS* IN TAMIL NADU

In a 2 m × 2 m × 1½ m concrete sided pit we had been housing about 30 *Echis carinatus* with pond, rocks, cacti and grass. When dry, the smooth pit walls are the barriers that we know from experience will safely contain "all" snakes under a certain length. When the walls are wet from rain however, we were surprised to see that *Echis* are able to slowly edge their way up the sheer wall. It seems that the suction created by their numerous ventral scales allows smaller and thinner (light) *Echis* to climb the 1½ metre wall in about 1 hour. This not to suggest that *Echis* habitually climbs smooth walls (i.e. houses etc.) as they will certainly follow the easiest route of travel.

Though *Echis* is essentially a ground viper and is collected in its northern range in India under rocks etc., in the south they seem to spend a large part of their time up in thorn bushes, cacti, century plants, in palmyra bark and even casurina trees and thatch roofts. This climbing trend is especially obvious during the rains when we find 80 per cent above ground in bushes and 20 per cent in and under stones, grass tufts, and very rarely in holes.

Echis are common in almost any part of Tamil Nadu that is dry and rocky and/or sandy. They are found in no forests except scrub jungle areas. The average length of *Echis carinatus* in the south is under 250 mm and is lighter in colour, more yellowish than the northern race or sub-species. Though bites are common (we treated 14 cases in the 3 months of July, August, September in a small rural area south of Madras in 1970) fatalities are very rare due to the snakes small size and effectiveness of antivenom serum.

MADRAS SNAKE PARK,
GUINDY DEER PARK,
MADRAS 22,
August 1973.

R. WHITAKER

20. ON THE FISHES OF THE GENUS *CTENOPS* McCLELLAND (1845)

During a study of the fishes of north Bihar (India) a well preserved specimen of *Ctenops nobilis* McClelland, from the collections of Zoological Survey of India, was noted. On comparison with the identified

material in Z.S.I. it revealed some distinct differences but as a solitary specimen it is not possible to give it a separate specific or subspecific status at present. A thorough examination of the material of the genus was done in this connection, and a detailed description of the species is given as the description given by McClelland (1845) is very brief.

McClelland (1845) proposed the genus *Ctenops* for an elegant anabantid fish from the rivers of Sikkim passing on northern frontiers of Bengal and described under it a species *C. nobilis*. Day (1877) synonmised *Ctenops* of McClelland with genus *Osphronemus* (Commerson) Lacépède (1801), changed the spelling of *Osphronemus* to *Osphromenus*. Day (1877), and Regan (1909) considered *Trichopsis* (Kner) Contestrini (1860), as a junior homonym of *Ctenops* McClelland, (1845) and other authors put *T. vittatus* under genus *Ctenops*.

However, Myers (Herre & Myers 1937) pronounced that the *C. nobilis* and *C. vittatus* have generic differences and proposed to retain genus *Trichopsis* (Kner) Contestrini for the latter. This taxonomic change has also been adopted by Smith (1945) and Forselius (1959) who thought it more appropriate to describe the Indian genus *Ctenops* as monospecific.

In the classification of the Teleostean fishes, Regan (1909) and Weber & deBeufort (1922) placed anabantoidei as a suborder of the order Labyrinthici. Berg (1940) and Greenwood *et al.* (1966) considered the association of these two groups as unnatural and their resemblance as due to convergence and transferred Anabantoidei as a Suborder of order Perciformes.

Genus *Ctenops* McClelland

1845. *Ctenops* McClelland, *Calcutta J. nat. Hist.* 5, p. 281. (Type Species: *C. nobilis* McClelland).

Description

Body oblong, compressed. Head acute. Snout equal or longer than the diameter of the eyes; lower margin of the enlarged lacrimal and the angle and lower margin of preopercle denticulated; premaxillaries and dentire with bands of small teeth; no teeth on the vomer and palatine; peripheral teeth enlarged; upper jaw portrusible; dorsal with 4-7 spines and 6-8 rays and inserted almost above the middle of soft anal; anal with 4-5 spines and 23 to 28 rays; median fins scaly at the base; ventrals inserted a little in advance of the pectorals, each with a strong spine and 5 rays, the first ray produced into a filament; scales arranged in regular rows. Those on body ctenoid while the one on head may or may not be ctenoid. Lateral line vestigial. The swim bladder extends into caudal region of the body.

Distribution: Confined to Assam, Bengal and Bihar.

Ctenops nobilis McClelland

1845. *Ctenops nobilis* McClelland, *Calcutta J. nat. Hist.*, 5, p. 281, pl. 21, fig. 1. (Type Loc.—Rivers of Sikkim passing on N. Frontiers of Bengal)
1849. *Trichopodus nobilis* Cantor, *J. Asiat. Soc. Bengal,* 18, p. 211.
1869. *Osphromenus nobilis* Day, *Proc. zool. Soc.,* London, p. 519.
1877. *Osphromenus nobilis* Day, Fishes of India, p. 372, pl. LXXVIII, fig. 5.
1909. *Ctenops nobilis* Regan, *Proc. zool. Soc.,* London, II, p. 777.
1922. *Ctenops nobilis* Weber & deBeufort, Fish. Indo-Aust. Archpel. 4, p. 1352.
1937. *Ctenops nobilis,* Shaw & Shebbeare, *J. Asiat. Soc. Bengal* 3, p. 113, fig. 118.

MATERIAL

a) Z.S.I. Regn. No. Cat. 333, Purnea, Bihar, Dr. Jerdon, one example 53 mm. Standard Length.
b) Z.S.I. Regn. No. Cat. 334, Dacca, Mus. Collector, One example 57 mm. S.L.
c) Z.S.I. Regn. No. 1565, Assam, Purchased from Dr. F. Day (original of Pl. LXXVIII, fig. 5 of Fishes of India), one example, 60 mm. S.L.
d) Z.S.I. Regn. No. 13343-45. Jessore Jheel, E. Pakistan, J. Wood Masson & Alcock, 3 exs. 41-66 mm. S.L.
e) Z.S.I. Regn. No. 7866-67. Dibrugarh, Dr. S. W. Kemp, 2 exs., 42-56 mm. in S.L.
f) Z.S.I. Regn. No. F 11425/1, Siliguri, N. Bengal, Messrs C. E. Shaw & E. O. Shebbeare, One exam., 60 mm. S.L.

B, VI, D. 4-6/6-8, P. 13, V. 1/5, A. 4-5/23-28, C. 16, Ll. 28-34. Ltr. 6/12.

A small elegant anabantid with body laterally flattened. Dorsal profile rises immediately behind the nape to the origin of the dorsal after which it descends down to the base. Ventral profile- likewise descends sharply from the mandibular edge to the origin of the anal fin after which it ascends gradually up to the base of the caudal. Head length 2.62 to 3.0 in the standard length. Eyes prominent lateral. Diameter of eyes 3.2 to 3.8 times the length of the head. Snout longer than diameter of eye. Snout dorsally convex and anteriorly flat and blunt. Diameter of eye 0.75 to 0.98 times snout length. Interorbital space almost flat and width more than length of snout. Nostrils paired, separated by a flat internarial membrane, nearer to eye than tip of the snout; gape wide. Lower jaw elongated to form a somewhat pipe shaped mouth. Lower jaw longer than upper; upper jaw portrusible.

Day (1877) and Weber & deBeufort (1922) stated that the end of intermaxillaries (premaxillaries) extends opposite to front border of the orbit. The intermaxillaries (premaxilla) do not extend to opposite the front border of the orbit in any of the examples studied here. The premaxillaries form the upper jaw and are broadened medially and narrow distally. The broad medial ends are produced backward into a rod like bony process; the two processes of either side lie opposed to each other

and conjointly form a medio-posterior process of the upper jaw and help in the protrusion and retraction of the upper jaw. These processes lie beneath the nasals. The underside of the premaxillaries bears a wide band of villiform teeth which are enlarged on the periphery. Maxillaries are toothless. Distal ends of the premaxillaries and the maxillaries lie close to each other, that of maxillary being on the outerside. The distal tip of maxillary is flattened.

The whole of maxillary and the distal part of the premaxillaries lie in a groove formed below the enlarged lachrymal (Preorbital of Day 1877, Regan 1909, and Weber & deBeufort 1922). The outer border of the lachrymal is toothed. The toothed band on the mandibles is of a similar nature as that of the upper jaw and has a series of enlarged peripheral teeth. The groove below the lachrymal extends on underside of the mandibles but the two sides do not meet below the mandibles. The lower lip is enlarged on the lateral side where it covers the retracted parts of the maxillaries.

Dorsal short, its origin lies about nearly the middle of the soft portion of the anal. Length of the base of the dorsal lies 4.4 to 6 times in the St. length whereas that of the anal base is 1.7 to 2.1 times.

Length of pectoral equal to half that of head or in some examples even somewhat less. Pelvics inserted a little in advance of the pectorals. Spine of the ventral strong and the outermost ray prolonged to varying lengths in all the examples studied here. Length of pelvic spine lies 2.0-2.48 times in length of head.

Except the naked part of the upper lip and the ventral side of the lower jaw, the whole body is covered by scales. The scaly sheath extends onto the basal part of the median fin. The lateral line is but slightly visible and irregularly pierces the scales. The scales of the body are more or less rectangular with the posterior margin convex and beset with ctene. The scales on the head may be smooth edged or minutely ctenoid. There are 28-34 scales along the lateral line while six above it and 12 below.

Coloration:

Colour in spirit brownish. A white band extends from behind the posterior border of orbit and runs uninterrupted below the lateral line upto opposite end of spiny portion of anal fin and thereafter to the base of the caudal in the form of white patches. Another interrupted white band originates from the area between the bases of the pectoral and pelvic fins and extends upto the middle of the soft portion of the anal. A third similar band extends upto the middle of the soft portion of the anal. At the upper part of the base of caudal there is a light edged dark brown ocellus. The ventral side of the head and abdomen are banded alternatively brown and white.

Ctenops sp.

The solitary specimen collected from Bettiah, Bihar, resembles *C. nobilis* in general but shows a few important differences as shown in the table below. It has been compared with specimens of similar length from Dibrugarh (Assam), Jessore Jheel (Bangladesh) and the differences are constant. The main differences being in the depth of body, the height of head at occiput and the length of the pelvic spine.

Ctenops sp.	*Ctenops nobilis* McClelland.
The depth of the body is less than the length of the head. (Being 1-2 times).	The depth of body either equal or more than the length of head. (Being 0.88-1 times).
The depth of body 3.4 times in standard length.	The depth of body is 3 or less than 3 times in standard length.
The height of body at caudal base lies 1.8 times in height of body.	The height of body at caudal base lies 2-2.6 times in the height of body.
The height of head at occiput is 1.1 times of the depth of body.	The height of head at occiput is 1.3 to 1.9 times in depth of body.
The length of pelvic spine goes 1.87 in length of head.	The length of pelvic spine goes 2.0-2.78 times in head length.
Snout is not longer than eye.	The snout is longer than eye.

ACKNOWLEDGEMENTS

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Thanks are also due to the Director, Zoological Survey of India, Calcutta for facilities provided.

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DEHRA DUN, (U.P.),
September 11, 1971.

K. P. SINGH

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21. AN INTERESTING CASE OF FISH SPAWNING IN AN OVERCROWDED NURSERY POND

Dubey & Tuli (1961) were the first to record the spawning of Indian major carps in standing water without any flow in two wet bundhs, namely Nagda and Bilaoli reservoirs, of Madhya Pradesh on sandy-clay and stony embankments respectively. Alikunhi *et al.* (1964) recorded major carps spawning in Neorapahari Tallaiya, an ordinary 0.08 ha pond with rocky embankments and sandy-silt bottom, near Nowgong (M.P.). The breeders were stocked in this pond from a nearby tank for induced breeding experiments about 10 days after the accumulation of fresh rain water. They also reported the spawning of catla, rohu and mrigal, soon after fresh rain water had collected, in two typical nursery-cum-rearing ponds (0.08 ha) at Jagatsagar (Nowgong, M.P.) with sandy substratum. There was no flow of water in any of these ponds. A similar case of spawning in a nursery pond, with standing water, at the Experiment Station, Adhartal Lake, Jabalpur, is reported here.

The 0.04 ha nursery pond (25 × 16 × 1.5 m) has been in use for fry rearing for over ten years in connection with the fisheries development programme in the Adhartal Lake (16 ha). This nursery normally dried up during summers but after the 1968 fry rearing season was over, some 500 rohu and 200 mrigal fingerlings, left behind in the nursery, continued to be reared in the pond, with the idea of raising a stock of breeders in the nursery itself. The nursery was filled with lake water at least thrice between February and June each year for the continued rearing of this stock. Between October 1969 and June 1971, the pond was stocked with common carp (*Cyprinus carpio* var. *communis;* 110 mm/25 gm), grass carp (*Ctenopharyngodon idella,* 82 mm/8gm), silver carp (*Hypophthalmichthys molitrix,* 118 mm/11 gm), prawns (*Macrobrachium malcolmsonii,* 55 mm) and mahseer (*Tor tor,* 100 mm) fingerlings. Wild spawning of common carp was recorded in the pond

in November, February-March and July-August each year on marginally growing para grass (*Brachiaria mutica*). Common carp also spawned when water was taken to fill this nursery from Adhartal Lake even in April-May when the air temperatures were as high as 35°-38°C.

Besides the fingerlings listed above, 25 catla (6-15 Kg), 6 rohu (2-4 Kg) and 6 mrigal (1-2 Kg) were further stocked in the nursery between October 1971 and June 1972 with a view to using them as breeders for hypophysation. These large-sized catla and rohu, however, did not mature nor was there any reduction in their mesenterial fat (Tripathi 1972).

The water of the pond was throughout highly turbid and the plankton density extremely poor (traces/50 1). The pH of the pond water varied from 7.5 to 8.2. The pond bottom had about 200-300 mm of loose muck. It often emitted a foul smell and bubbles of gas appeared on the water surface, especially on cloudy days.

During the 1972 monsoon season, mrigal and rohu breeders from this pond were used for hypophysation; the entire induced breeding work was done in the main lake. However, a dry spell from 10th July to 7th August affected the condition of mrigal breeders but rohu breeders continued to respond well to hypophysation even after 7th August 1972. There were heavy rains on 14th/15th August 1972 with 125 mm rainfall. The water level in the nursery, which stood at 442 mm in July, went up to 919 mm on the 15th August. Though there were sporadic rains between 16th and 29th August 1972, the water level in the pond had fallen to 634 mm. Heavy rains were again recorded on 29th August afternoon and it continued raining the whole night (29th/30th Aug.). It was the season's maximum record of rainfall on one day, the details of rainfall and temperature on 29th, 30th and 31st August are given below:

	Temperature (°C)		Rainfall (mm)
Date	Maximum	Minimum	
29-viii-72	23.3	23.3	78.7
30-viii-72	23.0	21.4	304.8
31-viii-72	24.2	21.4	19.3

The water level in the pond went up from 634 to 1164 mm on the 30th August. The dilution on the two occasions (15th and 30th Aug., 1972) could be said to be twice each time.

Despite a heavy downpour from about 2 p.m. onwards on 29th August, rohu breeders from this pond were collected and injected at 5.30 p.m. and about 2.97 lakhs eggs obtained on 30th August morning. Since it was very windy and fixing the hapas in the lake was difficult, breeders were not injected on 30th August evening. On 31st August, when rohu breeders were again collected for hypophysation it was found that they had already bred in the nursery. Though actual

breeding in the pond was not observed it is surmised that it took place in the early hours of 30th morning. A number of hauls were made and several breeders examined. The males were found to be oozing thin milt and the females gave out loose eggs on slight pressure on the abdomen as is commonly observed in case of spent breeders. Several hauls were then made with a plankton net but not a single egg or hatchling was obtained. Since common carp, of all sizes, predominated in the pond, it is possible that they had completely destroyed the eggs while those that survived had probably hatched out by the time the search was made and being few in number could not be collected by the plankton net. The season's fish breeding programme thus came to an abrupt halt.

Hauls made subsequently after a month on October 6, 1972, for the presence of small fry, if any, confirmed that spawning had taken place in the nursery. Six fry (35-40 mm) were collected in two hauls with a fine-meshed drag-net. Since large-sized catla and rohu were also present in the pond, further hauls with this drag-net were not made.

An analysis of the soil and water conditions of the pond after spawning (31st August '72) is given below:

Soil

Sand 63.75%, Silt 8.75%, Clay 27.50% Tex class Scl (Sandy-clay-loam).

Water

pH 7.9, K 6 (ppm), Na 18 (ppm), P 0.10 (ppm), Condivivity 200 (micromhos/cm), Total sol. salts 128 (ppm), Titrable alkalinity 2.3 (me/1).

Analysing the factors influencing the spawning of carps, Hora (1945) observed heavy monsoon floods to be the primary factor acting as a triggering mechanism for spawning. However, other workers have laid emphasis on topographical (David 1959), chemical (Mookerjee 1945; Saha *et al.* 1957) and physical (Khan 1945 and David 1959) conditions. Within the ranges encountered, it has been seen that pH, DO, free CO_2, total alkalinity and turbidity have not noticeable effect on spawning. Dasen (1945) considered monsoon floods from the hills as an indispensable factor as it has, besides, special physical and chemical, certain electromagnetic, properties apart from a peculiar smell or fragrance. Recently, Lake (1967), based on a series of experiments, has postulated that fish are stimulated by some factor resulting from inundation of dry ground or from water entering a pond or river after flowing over dry ground. In the present case, the question of fish getting stimulated by water entering the pond after flowing over dry ground cannot be considered as the bundhs and side slopes of the nursery could not be taken as "dry ground" towards the end of the mon-

soon season. It being a typical nursery there was no catchment area too. Rainwater had already entered the nursery on several occasions during the current season as also during the 1970 and 1971 monsoon season but with no effect.

Swingle (1953) has reported that spawning of fish is inhibited due to the presence of a hormone like excretion or secretion from fish that acts as a repressive factor. Though common carp spawned naturally in this pond during July-August, November and February-March, its breeding was noted on several occasions whenever the nursery was refilled with water from the main lake. It is possible that the dilution required to nullify the inhibiting effect of the factor for common carp is different than that for catla, rohu or mrigal. Swingle (1953) has further observed that "the repressive factor may be specific for a particular species or may affect other species". As already noted above, common carp bred profusely in this pond after a heavy shower on 16th August 1972 but perhaps this dilution was not enough for rohu. Rohu itself, however, bred on 30th August when the repressive factor specific for it was considerably diluted. It may be mentioned that spawning of any of the Indian major carps has never taken place in this nursery ever before and this is the first time that rohu have spawned in this pond.

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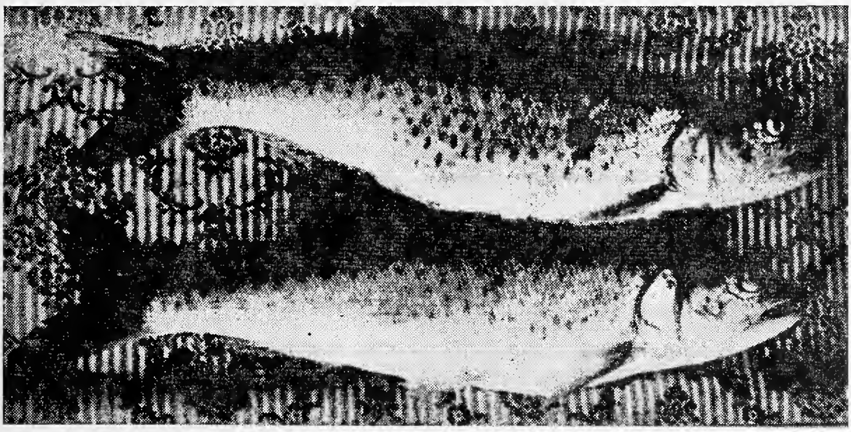
22. INTRODUCTION OF INDIAN TROUT IN LONAVALA WATERS

(*With a photograph*)

In 1926 Mr. F. V. Evans, a Vice Patron of the Bombay Natural History Society reproduced in the Society's *Journal* (Vol. *31*, p. 828) a letter published in 1831-32 in the *Oriental Sporting Magazine*, recording occurrence of a remarkable fish known as Indian trout, in great abundance, near Neemuch in the present Madhya Pradesh where officers of the army stationed at that place enjoyed the enviable treat of catching dozens of Indian trout in a couple of hours on artificial fly in the Chambal and Banas rivers. The letter also quotes a record of "the enormous number of 51 dozen of fine trout" caught in a day's fishing by three anglers. On another occasion 19 dozen per head were landed by two anglers. Being impressed by this attractive record and taking into consideration the altitude of Neemuch and Lonavala, Evans suggested introduction of this excellent game fish into Lonavala waters. Sir Reginald Spence, Hon. Secretary of the Society in 1932 and Mr. Prater, the then Curator, in their booklet THE GAME FISHES OF BOMBAY PRESIDENCY (1932) followed Evans in their recommendation of introducing the fish in Lonavala and stated "its introduction into some of the perennial streams of the Deccan would be a great acquisition". However, they regretted that no quotations were forthcoming for the supply of fingerlings of this fish for this purpose.

The recommendation of Evans, Spence and Prater went unattend-

ed for years because of the emphasis placed on the culture of rapidly growing food fishes in India in recent years. However, I had noted with interest the significance of transplantation of this outstanding game fish. Hence, when opportunity arose, efforts were made during the past two years to locate the source of fingerlings and arrange their collection. Fortunately, with the cooperation of Dr. G. P. Dubey, the Director of Fisheries, M.P. and Shri S. N. Chatterjee, Deputy Director, Gandhi Sagar Dam, 150 fingerlings were collected from a stream Gambhirnala, near the town of Jawad, about 30 km from Neemuch in Mandasor Dist. of M.P. The Gambhirnala meets Banas river and the latter joins Chambal near Sawai Madhopur in Rajasthan. (Incidentally, this Banas is different from the Banas which joins Sabarmati in Gujarat). About 115 of these fingerlings were brought to Bombay by train on November 11, 1974 and released into Tata Electric Company's fish farm and 65 grown up individuals released into Walwhan lake at Lonavala as an addition to the existing sport fish fauna of the lake.



A pair of *Raimas bola* Indian trout (juveniles).

The Indian trout, *Raimas bola* formerly, *Barilis bola* (Ham.) though it has no taxonomic relationship with the real trout of the salmon family, is commonly honoured with that suffix, largely because of the close similarity in the shape of body and coloration. Another happy analogue that attracts is its remarkable ability to take fly or fly spoon as avidly as the true trout, thus claiming a reputation as a splendid game fish. It also matches the trout in elegance and agility. To perpetually highlight these fine qualities the anglers preferred to call it the "Indian trout".

Day (1878) reported occurrence of Indian trout in Bengal, Orissa, Assam and N.W. Province and Burma but its distribution in Madhya Pradesh in the tributaries of the Chambal and in the lakes and streams of Rajasthan was not recorded till its mention by Evans (1926). 'Bola'

the specific name of the fish is derived from its Bengali local name; Hindi and Oria equivalents being *Buggarah* and *Buggnah*. In Assam it is called *Korang* or even '*Rajahmas*'. Recent enquiries indicate that fishermen at Jawad and also at Rampura on the Gandhi Sagar reservoir call the fish '*gallar*'. Day (op. cit.) reports capture of this fish in Assam weighing 5 lbs. This weight is on the high side but McDonald (1948) confirms having caught fish up to 3 lbs in Burma. Some of the adult specimens caught in the shallow streams near Jawad on November 9, 1974 measured about 30 cm and weighed 600 gms, though the fisherman of Rampura affirm that the fish attains a weight of 1 kg in the adjoining Gandhi Sagar reservoir constructed in 1962 (265 sq. miles) across the main Chambal river.

The present account places on record introduction of this fish into Lonavala waters of the Peninsular India where it did not occur in the past and fulfills one of the Society's recommendations. Practical significance of this introduction is to make available to the local anglers and tourists a most popular sporting fish. Many eminent anglers had wished to have the real trout into the Deccan waters but were disappointed to know that the real trout lived only in cold water like those in Kashmir and Ootacamund and would not thrive in the warm waters occurring elsewhere. But this 'gallar' (Indian trout) though it has all the necessary attributes of the real trout, does not suffer from the disability of requiring cold water for thriving healthily. The fish thus fulfills the need of the fly fishing sportsmen. However, since it is a riverine fish it is to be seen whether it would thrive in the lacustrine conditions of lakes.

It has, as will be evident from the illustration, an elegant, streamlined body, tapering at both ends. These features are clearly indicative of fast and active movement and in the field, it was seen actively darting and chasing small live fish. These lightning-like movements may sometimes excel even those of the celebrated Mahseer. Further it has undoubtedly been found to be a piscivorous fish as a number of fish specimens were seen in its stomach which has only a short double coiled gut, typical of a carnivorous habit. In this respect it has to be seen whether it would be a welcome addition into the piscicultural sphere, though no doubt, its propensity would be limited because of its small size. However, in large lakes it would certainly serve as an effective control of weed fish. Being a popular sport fish as well as good eating, its practical value in large lakes is fairly high. These factors have to be weighed carefully before spreading it into other habitats. Nevertheless, in the controlled conditions obtaining in the Walwhan lake, its introduction would be of considerable importance to anglers. It is further observed that the Indian trout which was, at one time, so abundant in the streams near Neemuch is now available only in small numbers,

a well grown three pounder being almost scarce. Inquiries reveal that it is met with very rarely in the commercial catches or in the markets in Bengal or Orissa. Even in the collections specially made in the Rajasthan waters, its occurrence is sporadic. Thus, these preliminary observations tend to point out that this one-time abundant game fish is now considerably reduced in its population largely due to apathy and ignorance about its value as a sporting stock. Serious efforts are, therefore, necessary to locate populations of Indian trout and to collect detailed information about its life history and possibilities of survival before it is too late to avoid its becoming extinct. Fishery Biologists in addition to their concern for food fishes should pay particular attention to this fine game fish.

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23. SOME INTERESTING METHODS OF FISHING FOR THE GIANT FRESHWATER PRAWN IN KERALA

(*With two text-figures*)

The giant freshwater prawn (*Macrobrachium rosenbergii*) known locally as *Konchu*, is in high demand and fetches handsome prices. Attracted by the high returns, people have been fishing for the species from every possible location in the backwaters, rivers and channels in central Kerala, adopting various ingenious methods.

Since some of the methods can be adopted with advantage in other parts of the country for catching the same or related species of prawns, a fairly detailed account is given.

Excepting the mode of fishing while the paddy fields are drained for cultivation or that adopted for catching the prawns hiding among submerged mangrove vegetation, in all other cases baits either dropped loose or suspended from floats are invariably used.

1. "*Koti Kuthi Veechu*" (Cast net fishing with marking poles and baits): This is the commonest method used in the Kuttanad area in Kerala. The gear used is a cast net[1] and baits dropped loose in water marking their position with long poles or *Koti*. The pole is usually the mid rachis of coconut leaves pointed at the base to facilitate fixing in mud and with a few leaflets at the free end to make it visible at night from a canoe, with a hurricane lamp fixed at its front end. Sometimes bamboo poles with a sheaf of leaves tied to the tops are also used as 'Koti'. The poles are four to five metres in length. A dug-out canoe, two men (one for rowing and the other for operating the cast net) and a cast net constitute a fishing unit (Fig. 1). About 12 to 15 marking

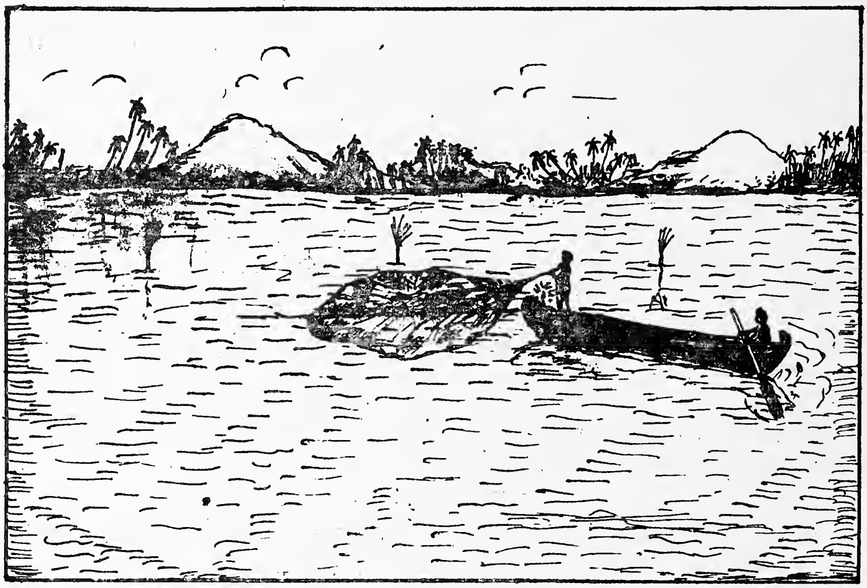

Fig. 1. Cast net fishing with marking poles and baits.

poles are used at a time and they are stacked inside the canoe or hung with sling ropes along the sides if the canoe is small. Raw tapioca (*Manihot utilissima*) or coconut oil-cake is used as bait. The latter is dropped as small pieces whereas the former is made into a coarse powder with the help of a grater made by perforating a tin plate with closely set nail holes. The paste made from the grated tapioca is rolled into small balls by hand. Like coconut oil-cake this has the advantage of spreading slowly when dropped to the bottom. The marking poles are planted in a row about 10 to 15 m apart after selecting a suitable stretch

[1] The measurements of cast net in common use are: mesh size – 1″, radius of the net 14-15′ and a circumferance of about 60-65′.

of the river or backwater with depths varying from 3 to 4 m and without any strong currents or eddies. The bait is dropped loose on one side of the pole at a convenient distance so as to allow sufficient space for operating the net. Baits are always put on the same side of all the poles in the row so that the canoe can be directed straight along one side while fishing. After allowing sometime for the prawns to approach the baits the net is cast above the baits. When the catch is quite good from an area, baits are dropped again and the net operated at the same spot without removing the poles from their original position. Sometimes fishing is done even without dropping the baits a second time. This type of fishing is carried out usually during the small hours of the morning when the prawns come out for feeding. Some fixed points along the shore or permanent structures in the water such as electric poles, pillars of jetties etc., are also used as land-marks for dropping baits.. Tapioca has been found more effective than coconut oil-cake in attracting prawns. One night's catch may be anything between 1 and 12 kg.

2. *Fishing with baits and floats*: This type of fishing is practised in deeper areas where the depth may be 6 to 8 m. Solid baits (boiled pieces of tapioca or coconut kernal) are tied to one end of a rope or string and a float or *Ponthu* (usually cut pieces of banana stem) to the other. A stone of suitable size is tied to the bait as a sinker to keep the bait a little above the bottom and to anchor it at a spot. A number of such baited sets are dropped at intervals of 7 to 10 m in a row. The floats in this case serve also as markers. But where there is a surface current the float will be drifting to one side and the net is cast taking into account the direction of the current and the position of the bait in relation to the float. In still and shallow waters the net is cast right over the float. This type of fishing is done during the day time.

3. *Fishing with "Ottal"*: Another type of gear used is "Ottal".[2] This is a contrivance made of fine bamboo strips lashed together in the form of a truncated cone open at both ends. This is the same as *Thapa* (Plunge basket) described by Chauhan (1946) and as *Poluha* or *Polo* (cover basket) by Job & Pantulu (1953). These are used in shallow areas especially in the flooded paddy fields where the depth may not exceed 1 m. Here again solid baits, usually boiled tapioca or coconut kernal are used. The flesh of greshwater apple snail, *Pila globosa* is also commonly used. These are tied to small floats made of cut pieces of the stalk of banana leaf. A small stone is tied for anchoring and keeping the bait a little above the bottom (Fig. 2 inset). The fisherman

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[2] The measurements of *Ottal* commonly used in this area are: Upper opening diameter—18 cm, lower diameter—75 cm, slanting side length—95 cm. The bamboo strips are also closely bound together so that the gaps between them may not exceed a few mm.

carries the *Ottal* and the floated baits in a canoe and drops the baits at regular intervals (Fig. 2). The float wobbles up and down when

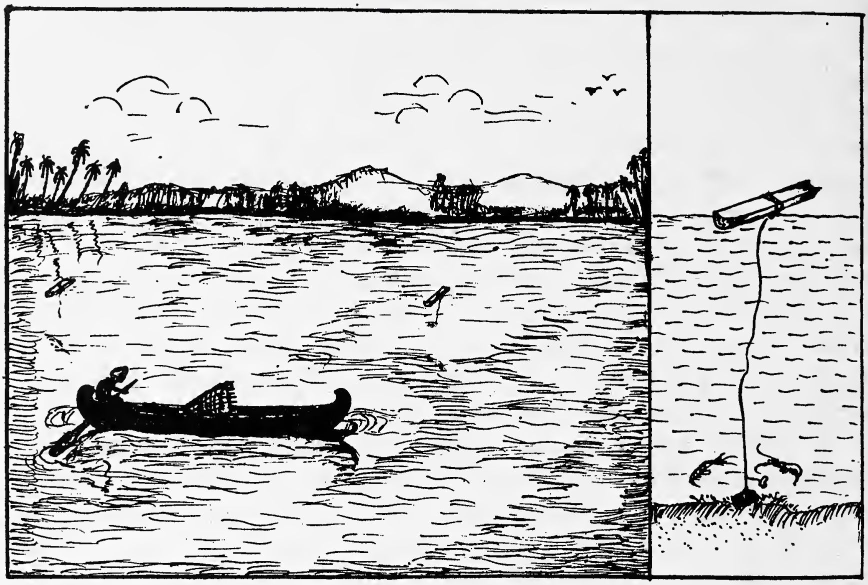

Fig. 2. Fishing with 'Ottal'.

a prawn nibbles at the bait and when the prawn gets at the bait with its pincers one end of the float remains dipped. Since this type of fishing is carried out during day time, movement of the float can be seen from a distance and the fisherman quietly approaches it in his canoe and plunges the *Ottal* over it. Prawns are taken out with hands or even with the legs where the depth is more.

4. "*Vativala*" *and* "*Vattavala*": *Vativala* is a drag net with a rectangular mouth across which sticks are attached transversely to keep it open and the net is operated by two men holding to the side sticks which are stouter than the others. This net is operated in shallow areas. *Vattavala* is a pouch net with a semi-circular mouth fitted with a bamboo frame of similar shape and is operated by two men in shallows, especially among submerged mangrove vegetation. The net is set near the vegetation and the water disturbed in such a way that the prawns hiding among the plants while trying to escape will get caught in the net. These vegetation are also encircled by the drag net *Vativala* and all the hiding prawns caught by disturbing the plants. *Vattavala* is also used for catching fishes and prawns from paddy field when the water is pumped out in preparation for cultivation.

Though these prawns are caught occasionally in stake nets and chinese dip nets during their sojourn in the backwaters they do not

form a major item in their catches at any time.

M. rosenbergii is also taken by hook and line in some areas of Vembanad lake between Vaikom and Cochin especially during their breeding season. It is also common practice to catch them from their hide-outs inside the crevices of stones and bunds by means of long metallic hook or pin. The prawns are impaled and taken out.

Evolving new baits by mixing some flavour or fish meal with the baits to attract the prawns easily and also studies on the relative efficiency of the various types of baits are lines of work worth considering in view of the great economic importance of the fishery.

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24. FOULING ORGANISMS ON FIBREGLASS COATED HULL OF A BOAT IN AN ESTUARINE ENVIRONMENT

(*With two text-figures*)

Fouling organisms collected from the fibreglass coated hull of the research vessel MLV TARINI which was used in an estuarine environment for 9 months from May 1970 to February 1971, revealed the nature and extent of settlement and the abundance of fouling fauna in the estuarine environment.

INTRODUCTION

This study deals with the settling of fouling organisms on the submerged portion of the fibreglass coated wooden hull of the research vessel MLV TARINI of the National Institute of Oceanography, at Panjim, Goa.

While the 15 m boat was in dry dock at Bombay, about 21 sq m area of its wooden hull was coated with fibreglass sheathing up to about 15 cm above the water line. The submerged portion of the hull formed about 18 sq m of the area. After making the boat sea worthy and equipped for oceanographic work, it was launched in early May 1970 and was brought to Panjim immediately for use in oceanographic studies in estuarine and nearshore waters of Goa region. The boat moved little during the peak southwest monsoon period from June to September, when it was anchored along-side a cement concrete jetty on the Mandovi estuary. From September to February the boat was extensively used in the estuarine and near shore waters of Goa. During the period a heavy settlement of fouling organisms was noted on the hull of the boat which necessitated scrapping in dry dock. This offered a chance to study the settlement of fouling communities on the fibreglass coated hull of the vessel which was used in an estuarine environment for nine months.

METHODS

Random samples in duplicate, each representing a unit area of 1 sq m were scrapped from the bow, stern, starboard and port sides. Wet weight and volume of each sample was recorded. The constituents were sorted, identified as far as possible up to species, and were weighed separately to estimate their percentage composition.

OBSERVATIONS AND COMMENTS

Experimental reports on the settling of fouling organisms on various wooden materials as well as those with different protective coat-

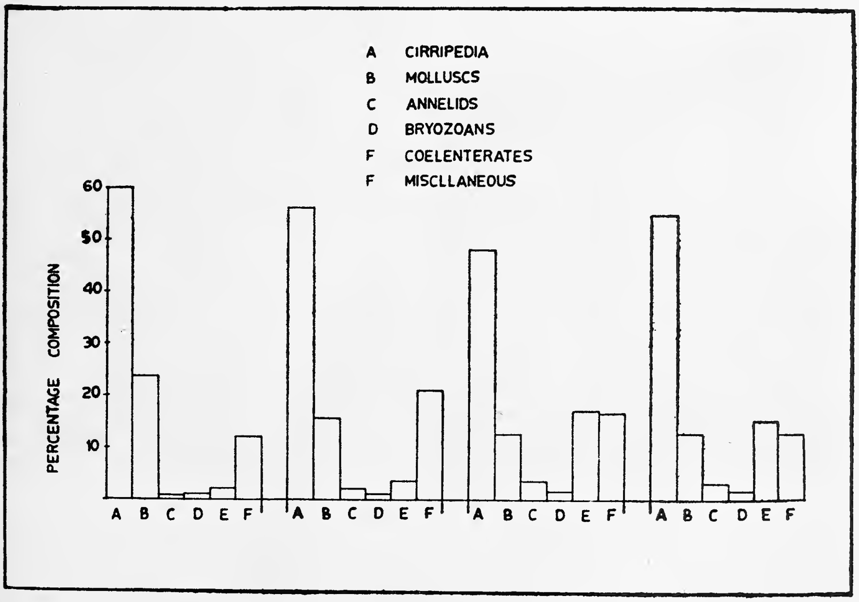
ings are numerous from different environments *in situ* (Kuriyan 1952; Nagbhushanam 1960; Nair 1961; Nair 1965; Balasubramaniyan *et al.* 1968; Karande 1969 and Balasubramanyan 1971). However, nothing is known about fouling organisms in the estuarine and nearshore waters around Goa.

The average weight of settlement per square metre was highest on the starboard side (600.80 gm/sq m) of the submerged portion of the hull, whereas the portside of the hull harboured second highest weight of settlement (439.70 gm/sq m). The stern side and bow side indicated average weight of settlement as 251.50 gm/sq m and 189.40 gm/sq m respectively.

An approximation of values of average settlement per sq m on different sides of the hull gives an average total settlement of about 1983 Kg of fouling organisms on 18 sq m submerged area of MLV TARINI in nine months from May 1970 to February 1971.

All the major fouling organisms namely cirripedes, molluscs, annelids, bryozoans, coelenterates as well as their associates were encountered in the samples collected from the hull.

Among the fouling organisms, the barnacles (cirripedia) were most abundant (Fig. 2B) and their percentage of composition all over the hull, was consistently high and varied from 53.63 per cent to 66.59 per cent per sq. m (Fig. 1). The settlement was so intense that the barna-



Starboard Port Stern Bow

FIG. 1. Diagrams showing the percentage composition of various fouling organisms on different sides of the hull of MLV TARINI.

cles were observed to have grown in 3 tiers or more, with the basal layer of dead shells. Another interesting feature was, the observed preference of site by bigger barnacles, *B. tintinnabulum tintinnabulum* which were congregated on the stern side whereas they were totally absent on other sides of the hull.

The molluscs, by their percentage ranging between 13. 79 per cent and 26.57 per cent per sq m were second highest in composition on all the sides of the hull. The occurrence of shell settlement was highest on starboard side compared to that on portside. (Fig. 1). The starboard side being always exposed, offers an easily accessible surface for settlement than the sheltered portside. Oysters and mussels were the main molluscan foulers (Fig. 2C).

The oysters were observed to settle on barnacle shells and not directly on the surface of the hull. Mussels occupied the major portion of the submerged surface, mainly because of their entangling byssus apparatus which, in turn harbours associates such as amphipods, isopods and crabs. Few specimens of *Scapharca* and *Martesia,* were also observed.

Annelids and Bryozoans formed a minor component of the fouling fauna and were found in consistently low percentage ranging

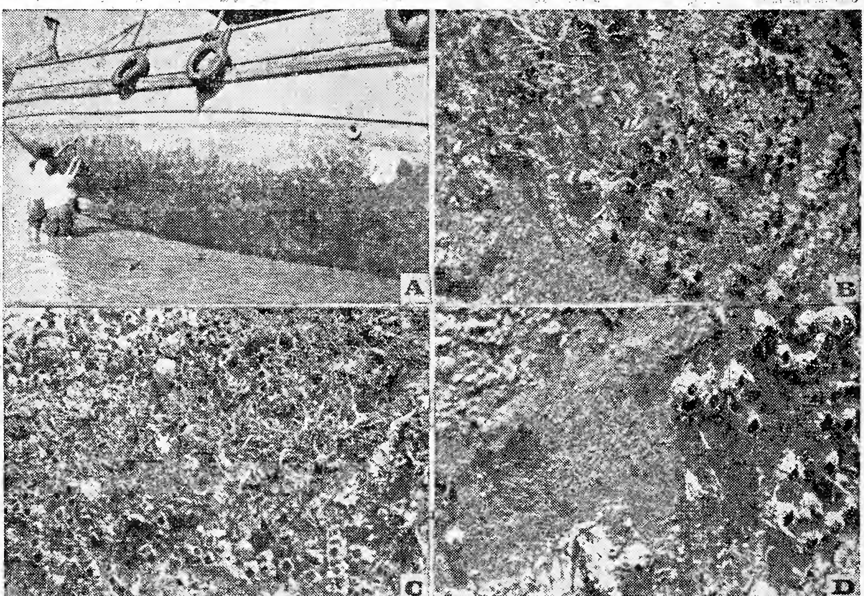


FIG. 2. A. General view of the fouling on the hull of MLV TARINI; B. Close up view of the starboard side hull of MLV TARINI showing settlement of barnacles, hydrozoans and bivalves; C. Close up view of the portside hull of MLV TARINI showing brancles, crab, hydrozoans and annelids; D. Close up view of the bow side of the hull of MLV TARINI showing early settlement of cirripeds along with branacles and annelids.

between 0.86%-4.06% and 0.99%-1.86%, respectively. Sessile forms dominating among the annelid-bryozoan component.

Coelenterates, especially hydrozoans appear to be a major fouling element in Goa waters as their settlement was dense and rich at places (Fig. 2D).

Of special interest is the selectivity of the hydrozoan settlement largely on the bow and stern sides as indicated by markedly high percentage of their occurrence in these area, (77% per sq m at stern and 16.1% per sq m at bow) compared to that on the side flanks (Fig. 1). Maximum turbulence at the stern area due to propeller action and the action of the current due to cutting of water at the bow area appear to be conducive factors for such predominent settlement on specific sites.

Hydrozoans are reported (Karande 1969) to cause considerable damage to the protective coating on the hull of the boats. However, the fibreglass coating on the hull of MLV TARINI did not show any apparent deterioration whatsoever.

Miscellaneous components consisting of animal associates, *viz.* amphipods, isopods, decapods and algal matter were found scattered along with ample silt and debris on all sides of the hull, and formed 13 per cent to 23 per cent per sq m of the average settlement. The highest concentration of miscellaneous constituents was recorded on the portside. The high percentage of miscellaneous constituents were probably the result of heavy precipitation in the waters of estuarine environment in Goa region (Dehadrai 1970). Passive settlement of silt and detritus which is characteristic of estuarine environment may not be considered among the fouling organisms, but it is of consequence as it thus enlarge the burden by constituting a sizeable part of the total settlement on the hull of the boat.

LIST OF FOULING SPECIES

CIRRIPEDIA

1. **Balanus amphitrite communis**
2. **B. a. variegatus**
3. **B. tintinnabulum tintinnabulum**

MOLLUSCS

4. **Ostrea madrasensis**
5. **Mytilus viridis**
6. **Modiolus traill**i
7. **Martesia** sp.
8. **Scapharca** sp.

ANNELIDS

9. **Hydroides** sp.
10. **Sabellid** sp.
11. **Spirobis** sp.

COELENTERATES

12. **Anemonia indicus**
13. **Cribrinopsis robertii**
14. **Actinia** sp.
15. **Sertularia** sp.
16. **Pennaria** sp.

BRYOZOANS

17. **Membraniopora** sp.
18. **Acanthodesia** sp.
19. **Electra** sp.
20. **Bugula** sp.

ISOPODS

21. **Ligia exotica**

AMPHIPODS

22. **Gammarus** sp.

DECAPODS

23. **Dotilla myctiroides**
24. **Uca** sp.

ALGAE

25. **Entermorpha** sp.

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25. THE GENUS *DELIAS* HUBN. FROM THE PLAINS OF ASSAM

I was interested to read Messrs Varshney & Nandi's note [*69*(3): 667-668] regarding the absence of the genus *Delias* from the plains of In-

dia. In Assam the genus is quite definitely not confined to the hills. In the plains of Sibsagar Dt. *Delias aglaia* (L.) and *descombesi leucantha* (Fruh) were two of our very common butterflies. They were succession brooded, the larvae feeding, as usual, on *Loranthus* spp. The following species were also taken in the plains from time to time:

agostina (Hew.) Occasional, Sibsagar Dt. and Margherita. Two only from Naga Hills.

hyparete hierte (Hub.) Sibsagar Dt. Not seen in Naga Hills.

thysbe pyramus (Wall). Sibsagar Dt. Not seen in Naga Hills.

As none of these was common in the neighbouring Naga Hills it would be unsafe to conclude without definite evidence of breeding habits that they were merely wanderers from the hills. The common Naga Hills spp. were *belladonna lugens* (Jord.) and *berinda berinda* (M.). These two I never saw in the plains.

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26. DANAID BUTTERFLIES ATTRACTED TO *HELIOTROPIUM INDICUM* (BORAGINACEAE), AN ALKALOID CONTAINING PLANT

(*With a plate*)

While on a survey to locate Bonnet macaque troops around Tulsi lake, on 22nd May, 1974, in company with Mr. P. Kannan, Curator for Animals, Borivli National Park, Maharashtra State, I observed a number of Danaid butterflies (*Danaus limniace* and *Euploea core*) clustered on a *Heliotropium indicum* plant which was in flower. At first I assumed that the butterflies were feeding on the flowers, but closer inspection revealed that all of them were clinging to, and feeding on, a dead and decaying inflorescence drooping from the plant.

On a subsequent occasion, on 4th September, 1974, I noticed 5 *Danaus limniace* hovering around, and intermittently settling upon, some newly flowering branches of a *Heliotropium indicum* growing on the bank of the pond near the offices of the Borivli National Park. I decided to find out whether they could be attracted away from this site to another *H. indicum* plant growing about 8 feet away. I crushed an inflorescence bearing few flowers of this latter plant, sufficient to extract the plant juice without distorting its rigidity, and waited. In a few minutes all the 5 specimens of *D. limniace* transferred their attention

to this plant and within seconds of arrival settled and avidly fed on the bruised portion of the plant. While I prepared to take a colour photograph of this group two more members of the same species joined them, making a total of seven. When I passed by the same path about an hour later a few *D. limniace* (perhaps new arrivals?) and 1 *D. chrysippus* were feeding on it.

A few days later, on 8th September, 1974, accompanied by my wife, I observed the same phenomenon on the road verges near the Aarey Milk Colony. Four specimens of *D. limniace* and four of *D. chrysippus* were feeding on some dead and withered branches of a *H. indicum* plant. I took a black-and-white photograph of this assemblage and observed that inspite of the disturbance we had caused in the area the butterflies repeatedly settled on the same branches to feed, so strongly did they seem to be attracted to this plant. We succeeded in capturing 3 specimens of the *D. limniace* (2 males and 1 female) and 1 specimen of *D. chrysippus* (1 male), determined their sex by examining for presence or absence of abdominal brushes ("hair-pencils") and hind wing pouches, and then released them.

The observations on the apparently unusual feeding behaviour recorded here resemble similar behavioural traits reported in Australian butterflies of the family Danaidae. Edgar, Culvenor and Robinson (1973) have reported from Queensland the attraction of *Danaus chrysippus petilea* (Stoll) to *Heliotropium amplexicaule* which is known to contain pyrrolizidine alkaloids. (Bull, Culvenor & Dick 1968). It has also been reported that Australian adult male danaid butterflies are strongly attracted to, and sometimes feed on, dead and withering plants containing pyrrolizidine alkaloids (Edgar, Culvenor & Robinson 1973). Furthermore, Edgar and Culvenor (1974) have pointed out the remarkable fact that danaid butterflies require pyrrolizidine alkaloids, which they possibly obtain from some of their food plants, and that these alkaloids may undergo metabolic alteration into compounds which are found in the hair-pencils of the abdominal brushes of male butterflies. Their suggestion is based on chemical investigations on extracts of hair-pencils of two species of Australian danaids. *D. hamatus* (Macleay) and *Euploea tulliolus tulliolus* (Fabricius) both of which contain pyrrolizidine alkaloids in their hair-pencils. It is pertinent too that the male courtship pheromone found in the hair-pencils of the American danaid, *D. gilippus berenice*, has been identified as a pyrrolizidine compound (Pliske & Eisner 1969). A neotropical danaid, *Lycorea ceres ceres*, is also reported to contain a pyrrolizidine compound in its hair-pencils (Meinwald, Meinwald, Wheeler, Eisner & Brower 1966).

Many species of *Heliotropium* found in India contain pyrrolizidine alkaloids, as also plants belonging to the genus *Crotalaria* (Legumin-

Danaid butterflies feeding on withering *Heliotropium indicum* inflorescences.
(*Photo*: *Author*)

osae), *Senecio* (Compositae), etc. (Watt & Breyer-Brandwijk 1962; Chopra, Chopra & Varma 1969; Chopra, Badhwar & Gosh 1965). *Heliotropium indicum* is reported to contain pyrrolizidine alkaloids, the major component being made up of Indicine (Mattocks *et al.* 1961; Mattocks 1967). It seems reasonable to suppose that acquisition of these alkaloids from food sources by danaid butterflies from vastly differing habitats and widely separated biogeographic areas may be a universal phenomenon. Thus it seems likely that the feeding behaviour of danaids, specifically attracted to *Heliotropium indicum*, described in this report is related to their requirement of pyrrolizidine alkaloids. Further studies on the inter-relations between such alkaloid-bearing plants and Indian butterflies belonging to the family Danaidae are in progress.

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27. NEW RECORD OF ARMY WORM *PSEUDOLETIA SEPARATA* WALKER (LEPIDOPTERA: NOCTUIDAE) AS A PEST OF RAGI IN INDIA

During May-December, 1972, observations on pest of ragi (*Eleusine coracana* L.) in some ragi fields of the Main Research Station, University of Agricultural Sciences, Hebbal revealed moderate infestation by a lepidopterous pest feeding on the foliage and the earheads. The pest was later indentified as *Pseudoletia separata* Walker.

The army worm is well known to infest a variety of food plants of cereal and millet groups. Ghosh (1924) reported it on sorghum, maize, paddy, wheat, oats and other millets. In addition to the above, pulse and vegetable crops were also found to be infested (Lefroy 1909; Fletcher 1914, and Ramchandra Rao 1924). Bindra & Rathore (1965) recorded it as a very destructive and sporadic pest of sorghum, maize, wheat and sugarcane. It was reported to cause severe damage to high yielding varieties of rice at the ripening stage of the crop by feeding on leaves and earheads (Kalode *et al.* 1972). In Mysore it is known to be a severe pest of sorghum and maize.

The present report of the damage by army worms to ragi crop from Mysore, therefore, is a new record of the pest on this host from India.

A brief account of the nature of injury by caterpillars to leaves and earheads, is given below.

The caterpillars, in the pre-earhead period, were found damaging the leaves during night making irregular cuts. The young caterpillars, in the laboratory rearings, were found to escape the leaves causing white membranous patches. The caterpillars hid below the loose soil around the base of the plant or in leaf sheath during day time. Their presence could be made out by the presence of faecal pellets strewn round the base of the plant or inside leaf sheath. About 47 per cent to 53 per cent of plants were infested. The number of larvae per clump varied from one to eight. The observations, continued till the harvest of the crop, revealed that the pest persisted and attacked the earhead in its various stages of development. They fed on the milky and later developed grains after dusk and concealed themselves by coiling at the base during daytime. The earhead thus damaged always had the faecal pellets and often with the caterpillars. The latter pupated in soil at the base of the plant or rarely inside leafsheath and in the earhead.

Further observations on its incidence and biology on ragi crop are in progress.

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28. OBSERVATIONS ON THE BIOLOGY AND HABITS OF *SYCANUS AFFINIS* REUT. (HEMIPTERA: REDUVIIDAE) AND ITS STATUS AS A PREDATOR

Sycanus affinis Reut. is a commonly occurring predator in Orissa and is found in fairly large numbers in coconut groves located in and around Bhubaneswar. The nymphs and adults of this species attack a large number of surface feeding lepidopterous larvae. So far nothing is known about the biology of this predator. However, Hoffman (1934)[1] has studied the life history of a closely related species, *Sycanus croceovittatus* Dohrn. An attempt was, therefore, made to investigate its life history and habits in order to assess its potentiality as an affective predator.

Laboratory cultures of *S. affinis* were maintained in insect cages. Ten pairs of one day old adult males and females were kept in each cage and these were supplied with full-grown larvae of *Corcyra cephalonica* S. The egg masses laid in cages were removed and kept in petri-

[1] HOFFMAN, W. E. (1934): The life-history and economic status of *Sycanus croceovittatus* Dohrn. (Hemiptera: Reduviidae). *Lengran Sci. J.* *13*(3):503-515.

dishes having a lining of filter paper. The date of egg laying was recorded. Ten nymphs, just after hatching, were transferred to a glass rearing jar of 15 × 10 cm size. The open end of the jar was covered with muslin cloth and held in position by rubber bands. Observations on the life history, feeding habits, host preference, preying potentialities of the different nymphal and adult stages were recorded. Five sets of such experiments were carried out in the laboratory. Three extra nymphs were reared in each set to serve as substitutes, the records of which were used in the event of unnatural death of any of the original ten nymphs. The laboratory temperature under which the biology of the predator was studied varied between 23.4 and 32.8°C.

Freshly emerged adult took 7 days to commence copulation. The egg mass contained a single layer of eggs arranged neatly in hexagonal shape. The female took about 3 minutes to lay each egg. The eggs were glued to the bottom with a sticky thread produced by the mother which soon dried up. An egg mass contained 24 to 152 eggs with an average of 100 eggs per cluster. The pre-oviposition period was 3 days and oviposition period varied from 6 to 37 days. The interval between two egg laying ranged from 5 to 10 days. The females were very prolific. A single female could produce a maximum of 807 eggs in confinement (Table 1).

The egg is brown, elongate, slightly bent in the middle, measures 2 mm in length, broad at the base (0.6 mm) and narrow at the top (0.4 mm). The anterior end has a white cap-like operculum. A black transverse line is present on the border between the operculum and the chorion. The chorion is smooth excepting the area lying beneath the black border line which contains a large number of punctuations. The incubation period varied from 14 to 24 days with 17.4 days on the average (Table 2). The per cent hatch ranged from 94.8 to 99.3. During eclosion the fully developed embryo pushed open the operculum. The nymphs took 30 to 40 minutes to extricate themselves from the chorion. Just after hatching, the nymphs sat upon the egg mass for about 10 minutes, stretched their legs, moved to the vicinity and remained congregated for some time.

There were five nymphal instars. Freshly moulted nymphs appeared light red. Their body coloration slowly changed from deep pink to black. The total body length from the clypeal end to the tip of the abdomen of the first, second, third, fourth and fifth instar nymphs was 3 mm, 5 mm, 7 mm, 11 mm and 18 mm respectively. The maximum body width of the nymphs was recorded at the third abdominal tergite. In all the nymphal instars there were three cone-shaped raised structures in the second, third and fourth abdominal tergites on the mid-dorsal line. Excepting the first nymphal instar, the rest of the instars contained four continuous, longitudinal white streaks, two lateral and two sub-

ventral, on the abdominal sternites.

The development period of the different nymphal instars and the total duration of life cycle are presented in Table 2. The table shows that the duration of the fifth nymphal instar is the longest (44.5 days) in April-May (Temp. Min. 28.8°C, Max. 35.5°C, Average 31.4°C and 69% R.H.) and the shortest (17.7 days) in June (Temp. Min. 28.8°C, Max. 35.5°C, Average 32.3°C and 75% R.H.). Egg masses laid during the first fortnight of December completed the life cycle in 152.4 days whereas those laid in the first fortnight of March needed only 81.7 days for completing development. The preimaginal mortality was mostly observed among the fifth instar nymphs. Under conditions of crowding and food scarcity cannibalism was observed mainly during the time of moulting.

The adult is dark in colour. The labium is three segmented, the apical segment is the smallest and contains a few sensory hairs at the tip. The mandibulary and maxillary stylets are strong. The former contains backward projecting barbs. The triangular scutellum contains in the centre a rosethorn-shaped spine projecting anteriorly. In the hemelytron, basal region of the corium and clavus of the coreaceous area are black whereas the apical halves contain a light yellow patch. The abdomen is boat-shaped containing 7 tergites and 6 sternites in the male while there are 8 tergites and 6 sternites in female. The total length of the female is 24 mm and that of the male 23 mm. In the female the tip of the abdomen is pointed whereas in male it is blunt. There is a preponderance of males, the male and female ratio being 5.5:4:5.

The adults are very long-lived and hardy. They could withstand extremes of temperature ranging from 15°C to 40°C. Under average laboratory temperature of 30.0°C the males lived longer (85.1 days) than the females (69.3 days). At 15.0°C the males lived for 16 days and females for 14 days whereas both males and females succumbed in two days at a constant temperature of 40°C. Adults lived without food for a period of 28.1 to 33.2 days in summer. Different nymphal instars lived for 8.6 to 41.2 days without food (Table 3) but the fourth nymphal instars survived for the maximum period.

The nymphs and adults are general predators. They were found to predate on a large number of larvae namely those of *Nephantis serinopa* M., *Sesamia inferens* W., *Prodenia litura* F., *Amsacta albistriga* W., *Acherontia styx* W., *Cirphis albistigma* M., *Papilio demoleus* L. and *Anomis sabulifera* G. Besides, nymphs of grasshoppers and cockroaches, white ants and aphids were also attacked. Larvae which were surface feeders were preferred most by nymphs and adults of the reduviid, those of the larvae which remained concealed e.g., in leaf galleries, leaf webbings, leaf case etc. were attacked by the adults only. Likewise, naked pupae and pupae in cocoons, were attacked by the

TABLE 1

FECUNDITY OF ADULT FEMALES OF *S. affinis* UNDER LABORATORY CONDITIONS (AVERAGE OF FIVE INDIVIDUALS IN EACH TEST)

Period of observation		Duration (days)				Total number of eggs laid per individual	Hatch ability percentage
From	To	Pre-oviposition period	Oviposition period	Interval between two consecutive egg layings	Number of egg masses laid per individual		
14-3-72	19-4-72	3	37	5-9	6	807	97.9
24-4-72	11-5-72	3	18	7-10	3	194	96.3
5-7-72	10-7-72	3	6	5	2	105	94.8

TABLE 2

MEAN DURATION OF VARIOUS STAGES IN THE LIFE-CYCLE OF *Sycanus affinis* UNDER LABORATORY CONDITIONS (AVERAGE OF 10 INDIVIDUALS IN EACH TEST)

Test No.	Period of observation		Temp. in °C during the developmental period			Duration (days)							Total duration of life cycle	Adult longevity (days)	
						Egg	Nymphal period								
	From	To	Min.	Max.	Average	period	I	II	III	IV	V	Total		Male	Female
1.	5-12-71	10-5-72	23.3	34.4	26.4	21	15.3	18.1	20.6	23.5	28.2	105.7	126.7	103.0	85.5
2.	13-12-71	16-6-72	23.3	35.5	29.8	24	17.8	18.0	22.1	26.0	44.5	128.4	152.4	88.6	72.5
3.	14-3-72	10-6-72	27.7	35.5	32.9	14	6.0	9.5	11.3	19.1	21.8	67.8	81.7	75.3	68.3
4.	19-3-72	3-7-72	27.7	35.5	32.0	14	10.0	10.4	17.8	18.5	20.3	77.0	91.0	84.2	70.0
5.	2-4-72	4-7-72	28.8	35.5	32.1	14	11.3	13.3	14.1	15.2	17.7	71.6	85.6	79.4	50.2
Mean						17.4	12.1	13.8	17.2	20.4	26.5	90.1	106.9	86.1	69.3
Range						14-24	5-26	7-27	11-27	12-30	15-56	52-163	64-187	75-103	50-85

TABLE 3

LONGEVITY (IN DAYS) OF NYMPHS AND ADULTS OF *S. affinis* WITHOUT FOOD UNDER LABORATORY CONDITIONS (MEANS BASED ON 10 OBSERVATIONS)

Period of observation		Nymphal instars					Adult
From	To	I	II	III	IV	V	
5-1-72	1-6-72	12.3	12.0	14.6	41.2	31.3	33.2
2-4-72	15-7-72	8.6	12.4	13.8	35.8	22.5	28.1

adults. When the attack was made on the pupae in cocoons, the adult pierced its stylets from a distance as otherwise the claws often got entangled in the webbings of the cocoons. Larvæ and pupæ remaining in stems and fruits were not attacked. The females were more virulent than the males with regard to the attack of the host. More than one nymph and adult may attack simultaneously a single host. The nymphs were observed sucking the body content of the host for 3 to 4 hours at a stretch. And adult female could overpower a larva of sphinx moth which was 37.2 times as heavy as the predator itself.

From a study to ascertain the maximum number of larvae eaten per day per individual, it was observed that the first four nymphal instars utilized less than one full grown larva of *C. cephalonica*. Once their appetite was satisfied, the nymphs did not attack the larvae even though the latter were in close proximity. However, the fifth instar nymphs and the adults sucked up the larvae at the rate of 1 and 5 respectively per day.

ACKNOWLEDGEMENT

We express our sincere thanks to the Director, Commonwealth Institute of Entomology, London for identifying the insect.

DEPARTMENT OF ENTOMOLOGY,
ORISSA UNIVERSITY OF AGRICULTURE
AND TECHNOLOGY, BHUBANESWAR 3,
ORISSA,
November 22, 1972.

J. M. SATPATHY
N. C. PATNAIK
A. P. SAMALO

29. ON THE OCCURRENCE OF *HOMOEOCERUS TAPROBANENSIS* DIST. (HEMIPTERA: COREIDAE) FROM POONA WITH A NOTE ON THE SCUTELLAR LEVIGATE LINE

Distant (1902)[1] while describing the species *Homoeocerus taprobanensis* had observed the presence of a central levigate line on head, pronotum and scutellum with the remark that it was obsolete on head. While studying some specimens from Poona I observed that the central levigate line to be well marked and continuous from head to the apex of scutellum in eight specimens, but in four others it was faint and slightly interrupted in the middle, in the region of scutellum. *Homoeocerus taprobanensis* was originally described from Sri Lanka and there is no further report available regarding its distribution.

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[1] DISTANT, W. L. (1902): The Fauna of British India, Rhynchota *1*:365-366.

Other characters: Lateral margins of pronotum pale levigate, convexium piceous with ochraceous spots, membrane piceous, sternum punctate.
Locality: Agricultural college, Poona, 8-ii-62. S. N. Chaubey, 12 exs.

ACKNOWLEDGEMENT

I thank Dr. B. K. Tikader, Dy. Director, Western Regional Station, Poona, for facilities offered.

WESTERN REGIONAL STATION, K. RAMACHANDRA RAO
ZOOLOGICAL SURVEY OF INDIA,
POONA 5,
December 26, 1972.

30. A PREDACIOUS PENTATOMID BUG, *CANTHECONIDEA FURCELLATA* (WOLFF) ATTACKING *LATOIA LEPIDA* (CRAMER) ON MANGO NEAR BANGALORE

(*With three plates*)

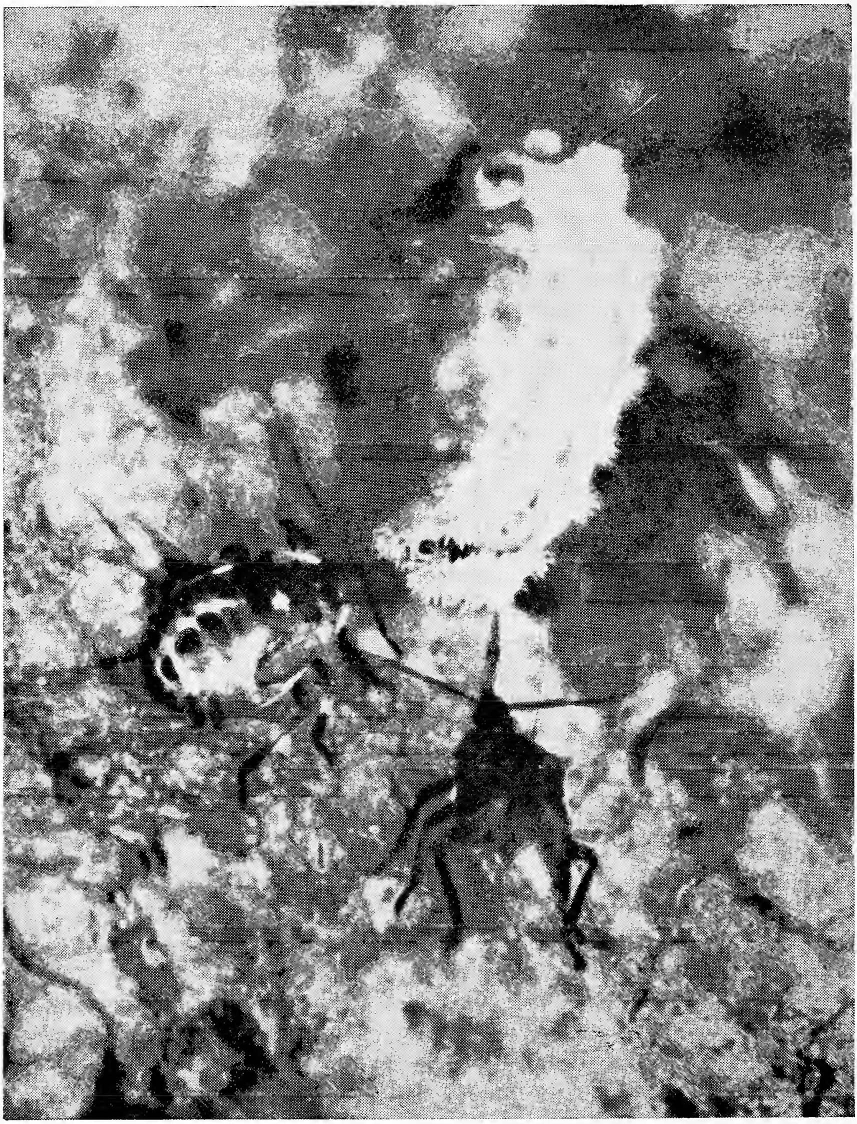
Our indigenous insect predators of crop pests have not received as much attention as have the parasites and very little information is available on them (Narayanan *et al.* 1967). Except for the more important predatory groups like the Coccinellidae for example, which have been fairly well studied, other equally useful groups—among whom may be mentioned the Mantodea, Reduviidae, Pentatomidae (Asopinae), Neuroptera, Carabidae, Asilidae, Syrphidae (Syrphinae), Chamaemyiidae and particularly the very abundant Spiders (Arachnida: Araneae) —have been overlooked in India.

During the course of my field surveys connected with studies on the Coccinellidae and Syrphidae, I came across a serious infestation of the slug caterpillar *Latoia* (= *Parasa*) *lepida* (Cramer) [Lepidoptera: Limacodidae] on some mango trees on a farm near Bangalore. On closer observation, several groups of the nymphs of *Cantheconidea*[1] *furcellata* (Wolff) [Hemiptera: Pentatomidae: Asopinae] were noticed on the cocoon-covered trunks (see plate I). The red and black coloured nymphs in all stages of development and the brownish adult bugs were observed attacking all instars of the host larvae including recently pupated ones.

The bug approached its prey stealthily, with rostrum extended, the

[1] The generic name is sometimes misspelled *Cantheconidia* by authors.

Mango tree trunk covered by cocoons of *Latoia lepida* (Cramer).
(*Photo*: *Author*)



Caterpillar of *Latoia lepida* (Cramer) being attacked by adult (left) and nymph (right) of *Cantheconidea furcellata* (Wolff).
(*Photo*: *Author*)

tip of which was thrust into the body of the slug caterpillar at any accessible point (see plate II). The injected toxin quickly immobilised the caterpillar which, on being attacked, had swayed its anterior end vigorously from side to side as an apparent defensive reaction. The completely sucked caterpillar turned almost black in colour and consisted of nothing more than the outer integument stuck flat to the substrate on account of the internal contents of the caterpillar having turned into a black, sticky substance as a result of the action of the toxin. Several such skins were noted attached to all parts of the trees (see plate III) and lying on the ground below them. The immature bugs are peculiarly gregarious in nature, especially in the earlier instars and even if a single individual actually initiates the attack, one or more others join it not much later. Each group of 2-4 bugs took about 20-60 minutes to fully suck dry a single caterpillar and my observations indicate that from 2-6 larvae were destroyed by one such group in a single day. From laboratory studies, Pant (1960) observed that nymphs consumed 7-8 larvae of *Earias* spp. each during their development (through 5 instars) and adult bugs fed upon 4-8 larvae each day. Gadd (1943) however, reported that one nymph of *Cantheconidea robusta* (Distant) destroyed 28 larvae of another limacodid on tea, *Natada nararia* Moore, in the course of its nymphal life and that a single adult bug killed 101 larvae in six weeks.

This is the first record of *C. furcellata* as a predator of *Latoia lepida* and only the second report of any predator of this limacodid. Ramakrishna Ayyar (1929) mentioned the association of a pyralid caterpillar, *Euzophera* (= *Phycita*) *dentilinella* (Hampson), with the larvae and pupae of *L. lepida* and thought it was predacious on the slug caterpillar. Radha & Rangarajan (1970) later recorded this pyralid as predacious on a lymantriid *Lymantria serva* Fabricius defoliating *Ficus bengalensis* Linnaeus near Coimbatore. They also mention that this pyralid predator was collected as early as 1914 on *L. lepida*. Thompson & Simmonds (1964) did not list any predators of *L. lepida* in their catalogue.

Cantheconidea furcellata however, is polyphagous and a large number of hosts, mainly lepidopterous larvae, are recorded by the following workers: Thompson & Simmonds (1965), Cherian & Brahmachari (1941), David & Basheer (1961), and Pant (1960). One very old host record in Distant (1902), overlooked by all these workers, gives *Hyblaea puera* Cramer and *Antheria paphia* Linnaeus (Tassar Silkworm) as two other prey species. The stink bug itself has very few recorded natural enemies, only one egg-parasite *Microphanurus seychellensis* Kieffer (Hymenoptera: Proctotrupoidea) being reported (Cherian & Brahmachari 1941). The total life cycle of the bug from egg to adult took 18-21 days (Cherian & Brahmachari 1941) and the adult longevity

was 15-20 days. In *C. robusta* the longevity was 51 days (Gadd 1943). Pant (1960) however, gives only 8-9 days as longevity of adult *C. furcellata* but De Jong (1931) records 28 days for the same species at Java. Present observations indicate that the life cycle varies from 15-18 days (from first instar nymph to adult, eggs not having been found or laid) and the maximum longevity of adult 12 days, in the laboratory.

C. furcellata has a wide distribution throughout the Oriental region, being recorded from India, Ceylon, Burma, Malaya, Sumatra, Java, Formosa and also Japan (Distant 1902). Although this species is capable of exercising fairly good natural control, it seems to be dependent on the presence of a sizeable host density to be really effective as observed in the case under report and by David & Basheer (1961). This being so, considerable damage is already done by the host insect concerned to the crop and as in coccinellids and, admittedly, in most predatory groups, the value of the predator is considerably reduced. However, since the bug is capable of producing favourable results, further studies on its potentialities in checking several lepidopterous pests and on possible means of its mass production would repay study.

Acknowledgement

I am grateful to Dr. G. P. Channa Basavanna, Entomologist, University of Agricultural Sciences, Bangalore, for facilities and a critical appraisal of the manuscript.

Department of Entomology, KUMAR D. GHORPADE
University of Agricultural Sciences,
Bangalore 560 024,
December 21, 1972.

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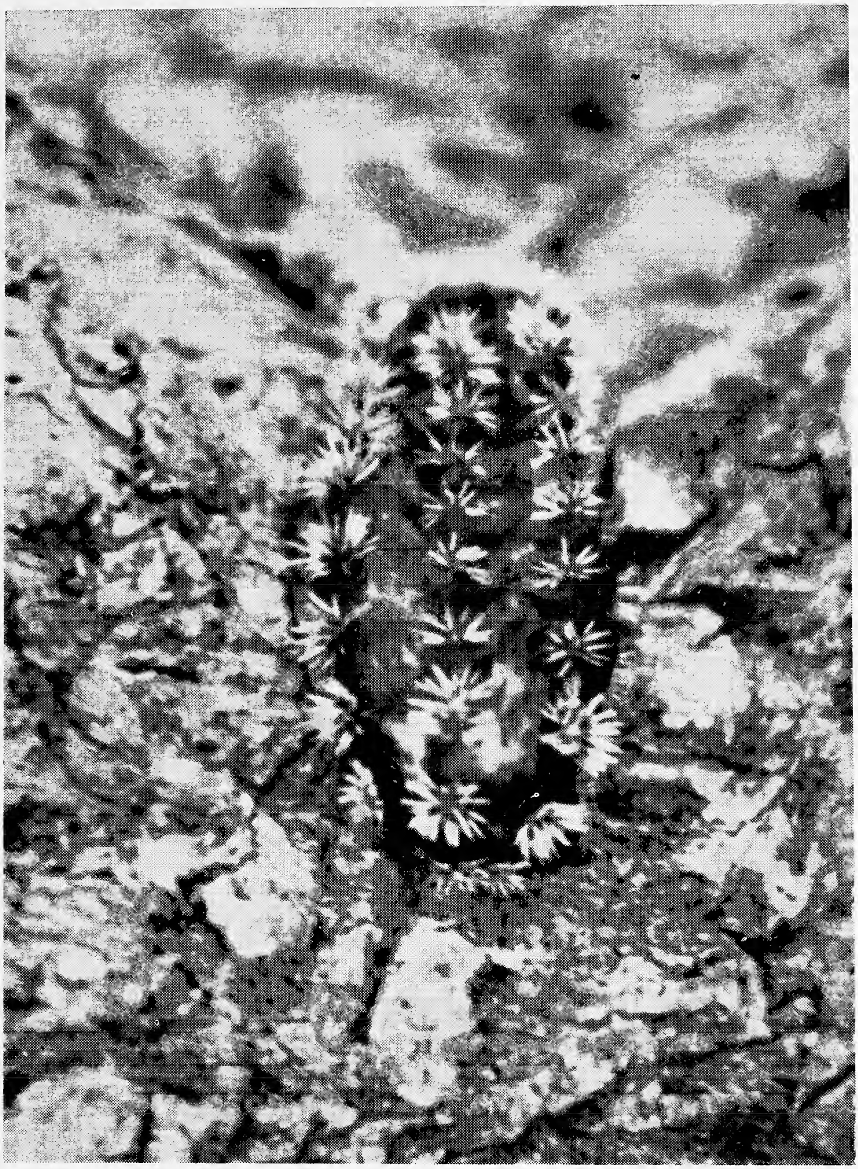

Completely sucked caterpillar of *Latoia lepida* (Cramer) stuck to mango tree branch.
(*Photo*: *Author*)

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——————— & ———————— (1965): op. cit. Section 4. Host Predator Catalogue. Reprint edition. Commonwealth Agricultural Bureaux, England. p. 198.

31. ON THE MODE OF PREYING OF A GIANT WATER BUG (*BELOSTOMA INDICUM* LE PELETIER & SERVILLE, 1775) ON A FROG (*RANA TIGERINA* DAUDIN, 1903)

The giant water bug's (Insecta: Hemiptera: Belostomatidae) habit of feeding on other fresh water fauna is well known. It is a menace to fishery owing to its predacious habit. Dimmock (1886) found some species of giant water bug that were destroying the young fishes in the state fish hatcheries of Massachusetts. No information, however, is available in the literature as to the exact mode by which it kills its large vertebrate preys like frogs, toads, salamanders and so on. Green (1901), who studied the biology of these bugs in aquaria, mentioned that large insects and other organisms falling on water constitute the main food of these bugs; and that, they also feed on frogs when they are able to catch them. Rankin (1935) used damaged tadpoles and pieces of young frogs to feed the nymphs of *Lethocerus americanus* in the culture he made for studying the life history of the species. It is, therefore, worthwhile to record here an observation on the exact mode of preying by one of such giant water bugs, namely *Belostoma indicum* on a frog, *Rana tigerina* in its natural habitat.

On August 23, 1972, I observed, while on a faunistic survey, near Kushnapur village (*c.* 4 km N.E. of Ghatgaon), Keonjhar district, Orissa, a tug-of-war between a nymph of *B. indicum* and a subadult *R. tigerina* in a temporary water pool, located in a paddy field. The bug had mounted on to the back of the frog and had tightly grabbed its gular region by the fore pair of legs, which are short and raptorial.

The frog often moved deep into water but immediately came up to the surface being unable to get rid of its predator. Such movements of the frog continued for 3-4 minutes. The bug, however, struck firmly to the back of the frog and tightened its grip further and further. Ultimately, the frog did not show any sign of movement and floated on the surface of the water while the bug still clung to its back. With the help of a water net both were brought ashore and even during this process the bug did not leave its prey. It was then forcibly removed from the frog, which had by then succumbed. The frog was examined thoroughly and no mark of injury in the form of puncture or otherwise was detected on its body. Even after rigorous squeezing no trace of blood could be detected on any region of body. In all probability the frog was strangled to death by the tight grip of the fore legs of the bug around its gular region.

Distant (1906) mentioned: "Its proboscis is capable of producing a very painful puncture", of which he himself had the experience from the South African giant water bug, *B. niloticum.* On the contrary, *B. indicum* (at least at its nymphal stage) appears not to rely on its proboscis for killing its prey and instead uses its fore pair of raptorial legs for strangling its large vertebrate prey to death.

ZOOLOGICAL SURVEY OF INDIA,
8, LINDSAY STREET,
CALCUTTA 16,
December 6, 1972.

S. K. MITRA

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32. DEATH OF CERTAIN INSECTS ON SHRUB *BIDENS PILOSA*

From a survey of literature it appears that not much information is available on insect ecology and associated plants. Recent studies on various groups of life forms including birds (Weed dispersal etc.—Bombay Natural History Society's Seminar on Economic Ornithology) have thrown light on various related factors deserving attention.

During field studies in Dehra Dun a fatal (to insects) relation between a shrub of the family compositae—*Bidens pilosa* Linn. with butterflies, dragonflies and damselflies was observed. The distribution of this shrub is throughout India. It was observed that at the time of seed dehisence the seed spikes project around the dried flower. At the tip of each seed spike are 1-2 mm V-shaped spines having backwardly directed micro spines. Any winged insect sitting on these is unable to fly off as the recurved spines hook on to its body or wings resulting in the death of the insect thereon. In Dehra Dun region this has been observed along the river Badal in Sahasdhara Hills and in Siwalik forests where often quite a few insects are seen dead on this shrub. However, there is no carnivorous relationship between the plant and the insects.

Incidentally it may be pointed out that it is this plant whose spikes are often found stuck on clothing during trek in the forests.

ACKNOWLEDGEMENTS

Grateful acknowledgements are due to Dr. R. K. Arora, Systematic Botanists, Plant Introduction Division, IARI, New Delhi for plant identification; Dr. Asket Singh, O/C North. Reg. Sta., Z.S.I. Dehra Dun, for facilities.

30-SOUTH PATEL NAGAR, R. K. BHATNAGAR
DEHRA DUN, (U.P.),
February 20, 1974.

33. NOMENCLATURAL NOTE ON *MIMUSOPS ELENGI* LINN.

In view of the taxonomic studies carried out by Lam (1925, 1927, 1932) and Van Royen (1952) on the genus *Mimusops* Linn., it has become necessary to put forward this note for the benefit of Indian botanists.

Van Royen (1952) considers *Mimusops elengi* Linn. an extremely variable species thereby leaving no room for distinguishing varieties or forms of Lam. But in the western parts of the Archipelago the leaves are larger up to 18 cm long and towards the east these decrease in size to 6 cm length, ending in the smaller leaves of *Mimusops parvifolia* R. Br.

The synonymy, in detail, is as follows:

Mimusops elengi Linn. Sp. Pl. 349, 1753; Lam in Bull. Jard. Bot. Bzg, sér. 3, 7:234, 1925; sér. 3, 8:479-480, 1927; and in Nova Guinea 14, 4:568, 1932; Van Royen in Blumea 6(3):594, 1952.

M. parvifolia R. Br. Prodr. 531, 1810; Lam in Bull. Jard. Bot. Bzg, sér. 3, 7:235, 1925.

M. elengi Linn. var. *typica* (*elengi*), var. *parvifolia* (R. Br.) Lam, var. *brevifolia* Lam and *M. elengi* Linn. var. *typica* (elengi), forma *longepedunculata* (Blume in Burck) Lam in Bull. Jard. Bot. Bzg, sér. 3, 7:235-238, 1925.

GENERAL EDUCATION CENTRE, G. M. OZA
MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA,
BARODA 2,
March 25, 1974.

34. NOCTURNAL POLLINATION IN *ANTIRRHINUM MAJUS* LINNAEUS BY *XYLOCOPA RUFESCENS* FABRICIUS

INTRODUCTION

In many regions of the World there exist a class of plants which blossom at night. This 'Nocturnal pollination system' has evolved in different plants of unrelated as well as related families. The study of the evolutionary aspect of night pollination has received very little attention so far. One of the most interesting aspects of night pollination is the role played by insects and other pollinators and the way these have become adapted along with the evolution of the plants. In this communication, some observations on the pollinating mechanism of the Snapdragon (*Antirrhinum majus* L.) is presented.

The plants are cultivated at a height of 4400 ft (*c.* 1340 m) in the Biligirirangan Hills, near buildings. It was possible to study the pollinator and its plant for several hours at night. Such careful and prolonged observations have excluded all other possible methods of pollination.

DESCRIPTION

The plant, commonly called 'snout flower' or 'snap dragon' (anti = like, rhin = snout) belongs to the family Scrophulariaceae. It is usually cultivated in gardens. The flowers are mildly fragrant and have an uncommon structure. They are borne on long spikes. The corolla tube is rather large and saccate at the base. There are two prominent and curiously shaped lips. On pressing these lips gently between the thumb and the forefinger, they open wide apart due to an intricate mechanism and reveal the variegated throat. The upper lip is erect and the lower lip spreading. The middle lobe is smaller than the side lobes with a large bearded palate. The flowers are of various shades of pink, rose, apricot, orange, crimson, carmine, yellow, white and many gradients of

colours varying from white to shades of light pink salmon, pale maroon and many other attractive combinations of hues in one flower, have been evolved due to intensive floriculture.

Its pollinator, *Xylocopa rufescens* Fabr. (commonly called the 'carpenter bee'; Xylocopa = wood cutter) belongs to the family Xylocopidae of the order Hymenoptera. *Xylocopa* are the giants of the bee world and are solitary bees. They have a heavy and stout black coloured body without the pollen baskets on the hind legs. Mouth parts are of 'chewing and lapping' type. Tongue long and slender. These bees bore energetically into dead branches and trunks of trees, and enter buildings where they bore into posts and rafters. They are nuisance not only on account of the damage done to rafters and beams, but also on account of wood dust and other refuse dropped out. They are usually present in forest rest houses and wooden bungalows. This species is strictly a nocturnal Indian carpenter bee. Tunnels are more or less cylindrical, an inch to 1.5 inches in diameter, up to 8 inches long, with short side branches. In this, a series of cells are constructed and each cell contains an egg along with bee bread and pollen (Tsing-Chao Ma 1938; Beeson 1938).

Pollination mechanism

The female carpenter bee starts its activity at about 7 p.m. in the evening. The bee appears to locate *Antirrhinum* at night purely by sight alone. It was found to visit white flowers more frequently than variegated ones, as possibly the white flowers are more easily seen during night. The shape of the flower fits neatly to the landing posture of the insect body. The insect with a high humming noise alights on the lower lip which goes down due to the weight thus applied and the insect inserts its head into the saccate tube. *Xylocopa* being chiefly a pollen collecting bee, assumes a pendent position under the anthers and by vibrating its wings slightly shakes out of the anthers the dry pollen grain on to the back of its body. When the insect happens to visit another flower, the stigma of that flower comes in contact with the back of the bee and is thus pollinated.

Discussion

'Failure' on the part of some species of flowering plants to compete with the innumerable day bloomers is believed to be the chief cause for the origin of nocturnal pollinating system in angiosperms. Presumably, the evolution of successful night bloomers should have been from

a stock of late day and dusk bloomers. From the latter would have evolved a line of night bloomers eventually through failure to withstand intense competition from the vast array of strictly day bloomers. A similar and a parallel changeover in the pollinating activity must have taken place among certain species of pollinators as is indicative in the *Antirrhinum-Xylocopa* type, where the co-adapted system is very clear. The nocturnal pollinating system in its infancy must have consisted of only a few species of night bloomers and their pollinators. But, now the pollinating system has reached a high density and has developed advanced stages of specialization.

ACKNOWLEDGEMENTS

We express our gratitude to Dr. B. A. Razi, Professor of Botany, Mysore University, Mysore for his kind suggestions and to Sri. D. Ganesh, Curator, Dept. of Botany, Mysore for help in photography.

DEPT. OF BOTANY,
UNIVERSITY OF MYSORE,
MANASAGANGOTRI,
MYSORE, 570 006,
February 6, 1974.

V. BHASKAR
K. GOPINATH

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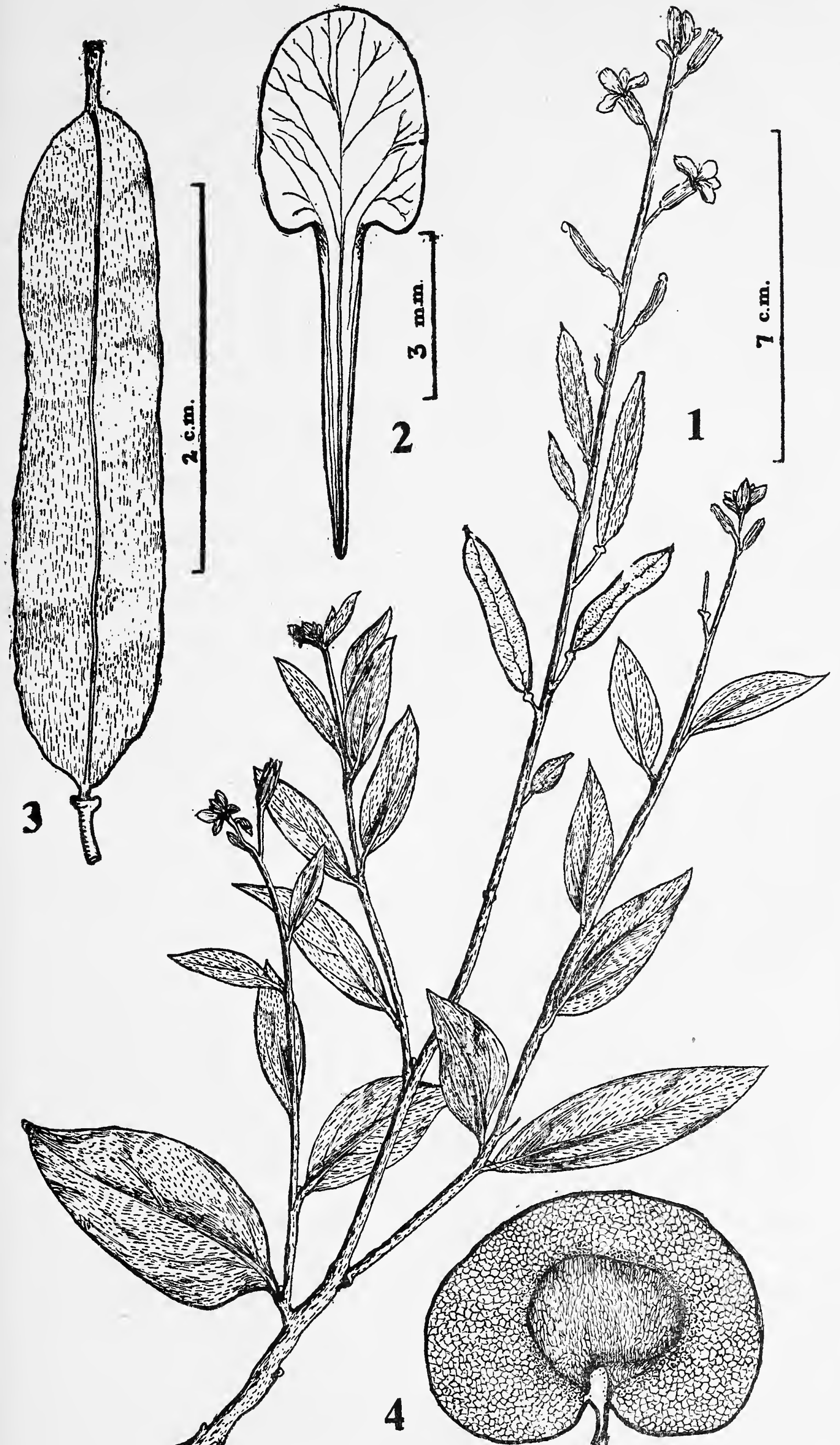
35. NEOTYPE OF *FARSETIA MACRANTHA* BLATT. & HALLB. (CRUCIFERAE)

(*With four text-figures*)

Farsetia macrantha which Blatter & Hallberg (1918) described as a new species from the Indian Desert, has been put in the synonymy of *Farsetia jacquemontii* Hook. f. & Thoms. by Jafri (1957), although he, in his own words "could not examine any material of *F. macrantha* Blatt. & Hallb., but from the measurements given in the specific description (*F. macrantha*) it fits easily within the limits of the same group" (i.e., *F. jacquemontii* sub sp. *jacquemontii*). While a detailed study, whether *F. macrantha* is conspecific with *F. jacquemontii*, is under progress, a search has been made for the type of *Farsetia macrantha*.



Farsetia macrantha Blatt. & Hallb. FIGS. 1. a flowering branch; 2. a petal; 3. a siliqua; 4. a winged seed (based on *Bhandari* 507).

Blatter & Hallberg (loc. cit.) quoted 3 numbers of their new species i.e., *Blatter* 5785, 7300 & 7305, of which only the last two were available for comparison and study in 1954 when the author first visited Blatter Herbarium where the entire collection of Blatter, including the 'types' have been preserved. Santapau (1959) while designating the lectotypes of species of Blatter & Hallberg from the Indian Desert, could not designate any lectotype of *F. macrantha,* since all the original material has, presumably been, lost or destroyed. None of these sheets could be traced when the author visited Blatter Herbarium again in 1960 and 1963.

This species has been described by Blatter and Hallberg from Barmer rocks. Despite extensive survey of the entire Indian Desert, *F. macrantha* has been observed only at one place i.e. behind Mataji's Temple, Barmer, on rocks—the type locality from where *F. macrantha* was first described by Blatter and Hallberg and where the species grows in abundance. This species has subsequently been collected from the same locality (Rolla & Kanodia 1962). To the best of my knowledge none of the material of this species has yet been designated as 'type'. I, therefore, designate *Bhandari* 507 a 'standard specimen' or "neotype", exemplifying the true application of the name *F. macrantha* Blatt. & Hallb. and to ascertain with certainty the sense in which the same must be used. The specimen comes from the type locality and is in complete agreement with the original diagnosis. For easy identification of the species, line drawings of it have also been given (Figs. 1-4).

DEPARTMENT OF BOTANY,
UNIVERSITY OF JODHPUR,
JODHPUR,
February 2, 1974.

M. M. BHANDARI

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36. *CUSCUTA REFLEXA* ROXB.—A RIVAL TO *DENDROPHTHOE FALCATA* (L.F.) ETTINGSH IN HOME GARDENS

Among the phanerogamic parasites, *Dendrophthoe falcata* Ettingsh has received considerable attention. *Cuscuta* belonging to N.O. Convolvulaceae is not so well known. The number of species of the genus *Cuscuta* has been reported as 7 (Hooker 1885), 5 (Gamble 1956 reprint) and 8 (Shareefuddin Khan 1951). Data on parasitism has been provided by Narayan 1956; Chavan & Sabnis 1960, and some contributions regarding its host range have also been made.

During 1971, 1972 due to unknown factors *Cuscuta reflexa* Roxb. suddenly started spreading in the Deccan from Hyderabad to Bangalore showing itself as yellowish green, leafless, tendril like growth having a coverage and spread. This alarmed orchard and garden owners. Frequently *Cuscuta reflexa* has been confused with *Cassytha* Linn. species belonging to N.O. Lauraceae which is also a complete flowering parasite. The two species however can be easily differentiated from each other. The stem tendrils of *Cassytha* are smaller in diameter, dark green to rusty orange, not easily breakable (fibrous), and overall, the parasite is not as much conspicuous as *Cuscuta. Cuscuta reflexa,* on the other hand, is light yellowish (or greenish yellow) to orange, more succulent and easily breakable, very conspicuous and may completely cover the host plant. Frequently the vines turn self parasitic on other branches of the parasite *Cuscuta* or on the same branch itself. As regards the flowers and fruits, the flowers of *Cassytha* are yellow to cream coloured, the fruit is glabrous, upto the size of a pea enclosed in a succulent perianth tube, and crowned by its limb, with a mono-carpellary ovary. The flowers of *Cuscuta reflexa* are white in cymose or paniculate clusters, shortly pedicilate, capsules globose to conical, apiculate, seeds 1-2. It also appears that *Cassytha* is more common on wild plants than on garden plants.

Several attempts at citing the host range of *Cuscuta reflexa* have been made by earlier workers and Kaushik (1970) has mentioned that there are 90 different hosts of this parasite belonging to Angiosperms, Gymnosperms and Pteridophytes. In addition, he added 14 new hosts to the host range. When compared to the host range of *Dendrophthoe falcata* which is nearly 330, this figure appears very small indeed. Probably clear distinction between *Cassytha* and *Cuscuta* and more elaborate search of hosts might bring in many more unknown hosts.

During 1971 and 1972 when the appearance of *C. reflexa* became so prolific in the cities of Hyderabad and Bangalore we came across several hosts, among which, as far as is known to us, the following 18 are new host records. Out of these, 13 are plants which are usually grown and maintained in home gardens and one is cultivated for oil

extraction (*Ricinus communis*).

TABLE

No.	Host species	Natural order	Degree of infestation
1.	*Aristolochia bractata* Retz.	Aristolochiaceae	Light
2.	*Argyreia speciosa* Sw.	Convolvulaceae	Light
3.	*Bougainvillea spectabilis* Willd.	Nyctaginaceae	Very heavy
4.	*Casurina equisetifolia* L.	Casurinaceae	Very heavy
5.	*Citrus decumana* L.	Rutaceae	Medium
6.	*Citrus medica* L. var. *acida*	Rutaceae	Medium
7.	*Cryptostegia grandiflora* R. Br.	Asclepiadaceae	Medium
8.	*Diospyros melanoxylon* Roxb.	Ebenaceae	Medium
9.	*Duranta plumieri* Jacq.	Verbenaceae	Heavy
10.	*Ervatamia divaricata* (L.) Burkill (Syn. *Taberinamontana coronaria* R. Br.)	Apocynaceae	Medium
11.	*Grewia subinaequalis* DC.	Teliaceae	Medium
12.	*Jasminum grandiflorum* L.	Oleaceae	Very heavy
13.	*Leptadinia reticulata* W.A.	Asclepiadaceae	Very heavy
14.	*Millingtonia hortensis* Linn.	Bignoniaceae	Very heavy
15.	*Ormocarpum sennoides* DC.	Leguminosae	Heavy
16.	*Ricinus communis* L.	Euphorbiaceae	Medium
17.	*Thevetia neriifolia* Juss.	Apocynaceae	Very heavy
18.	*Zizyphus oenoplia* Thuill	Rhamnaceae	Light

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37. NEW PLANT RECORDS FOR INDIA FROM KASHMIR—II

(*With two text-figures*)

Based upon the occasional collections made during 1968-1973 throughout the Kashmir valley, I reported *Phacelia tanacetifolia* Benth. and *Sideritis montana* Linn. as two new records for India (See *J. Bombay nat Hist. Soc. 69*:229, 1972). This paper adds two new composites for India namely: (1) *Aster pilosus* Willd. var. *demotus* Blake recorded as "escape from cultivation, chakrah 7000 ft on 29-ix-1936" on a specimen deposited at KEW and (2) *Chrysanthemum parthenium* (Linn.) Bernh. of which one specimen collected by Falconer (1864) from Kashmir is deposited at Kew.

The fresh specimens of these plants have been deposited at Royal Botanical Gardens, Kew, and Blatter Herbarium, Bombay.

Aster pilosus Willd. var. **demotus** Blake in Rhodora 32:139, 1930.

A. ericoides Auct. (non Linn. Sp. pl. 875, 1753). [Fig. 1].

Annual herbs: Stem suberect to decumbent, upto 75 cm branched, leafy, slightly angled towards the base, downy greyish or tomentose towards the apices. Leaves simple, linear, filiform, upto 3.7 cm long, tips acute; crowded towards the apices; alternate, light green, somewhat downy or tomentose. Flower heads white with purplish tinge, generally solitary on a short leafy branch, panicled. Involucral bracts 2-3 seriate; outer ones a bit smaller up to 5 mm long; inner ones up to 7 mm long, obovate to linear, margins membranous, slightly downy and persistent. Flowers heterogamous; ray florets 2-4 seriate, ligule up to 1 cm, entire or bifid near the apex, female, fertile, style half as long as the ligule with 2 small diverging arms near the apex; disc florets purplish, *alpha*-seriate, corolla tube 4-5 fid, stamens 5, anthers with obtuse bases coming out of the tube at maturity, style similar to that of ray florets. Receptacle small, simple and naked. Achenes elongated upto 1 mm, whitish, tapering towards the base, finely hirsute; pappus white, almost 3 times the length of achenes.

Distribution: A native of America and introduced into Kashmir.

Specimens examined: Kaul RRL 19727 (21-x-1970) Badgam Orchards, Rare. Kaul RRL 19801 (31-x-1970) Gulmarg Forests.

Chrysanthemum parthenium (Linn.) Bernh. Syst. Verz. Erf. 145, 1800; Aitch. in J. Linn. Soc. 18 : 69, 1880; Kitamura in Fl. Afghanistan 402, 1960; Polunin in Fls. Europe 443, 1969. *Pyrethrum parthenium* (Linn.) Smith in Fl. Britannica 2 : 900, 1800. [Fig. 2].

Perennial branched herbs with a somewhat creeping root stock. Stem woody below erect up to 60 cm, branched, light green, ribbed, finely tomentose towards the apex. Leaves pinnate up to 8 cm long,

with 3-7 oval leaflets, each further divided into narrow, oval, toothed or lobed segments, strongly aromatic; lower cauline leaves stalked, stalk slender, as long or shorter than the leaf; upper ones pinnatifid to pinnatisect, sessile to subsessile, glabrous or minutely pubescent. Flower heads long, stalked, forming subcorymbose compound heads. Involucral bracts ovate, 1-2 seriate, downy with membranous margins. Ray florets

FIG. 1. *Aster pilosus* Willd. var. *demotus* Blake (A flowering shoot). a. an involucral bract; b. a disc floret; c. a ray floret; d. an achene.

in a single outer row, ligules white, 3-5 fid, female, fertile or even sterile. Disc florets many, yellowish, compact in the centre; corolla tube 3-5 fid, stamens with linear anthers, style truncate. Achenes whitish, somewhat cuneate, tapering towards the base, glabrous or minutely hispidulous. Receptacle naked.

FIG. 2. *Chrysanthemum parthenium* (Linn.) Bernh. (A flowering shoot). a. an involucral bract; b. a ligule; c. a disc floret; d. an achene.

DISTRIBUTION: Europe, Transcaucasia, Caucasus, Asia minor, Afghanistan.
Specimens examined: Kaul RRL 19706 (15-x-1970) Majid Bagh, Srinagar.

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38. SOME INTERESTING PLANTS FROM RAJASTHAN

A perusal of up-to-date literature on the vegetation of Rajasthan reveals that north-east, north-west, and western parts of the state have been intensively explored so far. South-eastern plateau of Rajasthan, which extends over Kotah, Bundi and Jhalawarh districts, has not been given due consideration; the notable contributions from this plateau are those of Jain & Kotwal (1960), Gupta (1965, 1966), Singh (1970) and Maheshwari & Singh (1972).

During botanical exploration of south-eastern plateau of Rajasthan, I noted that about 21 species, belonging to 19 genera and 9 families, have not been recorded earlier from any locality in Rajasthan. These species are enumerated below and each specific name is accompanied by its field number, frequency and abundance in the area, habitat with exact locality of occurrence and flowering and fruiting times. In the present paper 17 new records for "The Flora of Upper Gangetic Plain" have also been mentioned for the first time from this area and few species have been reported for the second time from Rajasthan. Earlier these species have been known from Mt. Abu, the highest peak of Aravallis.

The herbarium specimens are deposited in the Herbarium of National Botanic Gardens, Lucknow (LWG).

POLYGALACEAE

Polygala erioptera DC. var. **vahliana** (DC.) Chodat (90504). Rare; occurs in dry, rocky wastelands near Kotah. This variety differs

from nominate species in the characters of pubescence and hairiness. *Fl.* & *Fr.*: August-October.

ELATINACEAE

Bergia capensis Linn. (83733). Abundant on sandy and marshy banks of streams near Jhalawarh. *Fl.* & *Fr.*: August-November.

RHAMNACEAE

Ventilago denticulata Willd. (74408). Occasional; found on the hill-slopes in deciduous forests at Kotah-Dam. *Fl.* & *Fr.*: December-April.

CAESALPINIACEAE

Hardwickia binata Roxb. (91020). Rare; few plants found in the teak forests near Atru village. *Fl.* & *Fr.*: December-July.

UMBELLIFERAE

Ammi majus Linn. (74009). Rare; found in patches in wet and shady places in the evergreen forests of Sitabari (Kelwara). *Fl.* & *Fr.*: March-April.

SOLANACEAE

Physalis minima Linn. var. **indica** Cl. (90376). Rare; found in gardens and fields near Chhabra village. *Fl.* & *Fr.*: September-January.

PLANTAGINACEAE

Plantago pumila Willd. (90850). Rare; weed of cultivated fields near Baran. *Fl.* & *Fr.*: January-March.

EUPHORBIACEAE

Chrozophora parvifolia Klotz. ex Schfth. (83831, 90953). Common in drying ponds and ditches, particularly near Darah and Chhabra villages. Plants grow in association with *Gnaphalium pulvinatum* Del. *Fl.* & *Fr.*: April-July.

GRAMINEAE

Arthraxon hispidus (Thumb). Makino f. **muriculatus** Hook. (74608). Rare; found in dry habitats on the hills near Darah. *Fl.* & *Fr.*: August-October.

Brachiaria eruciformis (J. E. Smith) Griseb. (74498, 83770). Common in dry habitats near Hindoli and Jhalarapatan. Plant is distinguished by its raceme and leaf-blades which are at right angle of leaf-sheaths. *Fl.* & *Fr.*: October-May.

B. reptans (Linn.) Gard. & Hubb. (83655). Common on wet or marshy banks of ponds and rivers and as a weed of cultivation near Manoharthana. *Fl.* & *Fr.*: July-November.

B. setigera (Retz.) Hubb. (74834). Common on the hills at low elevation in wet and shady habitats near Darah. *Fl.* & *Fr.*: August-November.

Dimeria connivens Hack. (83741). Occasional; found in grasslands and in the forests near Jhalawarh. Sometimes confused for *Dichanthium* Will. or *Bothriochloa* O. Ktze. *Fl.* & *Fr.*: August-November.

Dichanthium aristatum (Poir.) Hubb. (90131). Rare; found in dry wastelands near Kotah. *Fl.* & *Fr.*: August-November.

Eragrostis papposa (Duf.) Steud. (83633). Occasional; found in dry sandy or rocky grounds near Nenwa village. Branches, branchlets and glumes are tinged with purple. *Fl.* & *Fr,*: June-August.

Ischaemum pilosum (Klein ex Willd.) Wight (83729). Common; found in waste, sandy or rocky grounds near Jhalawarh and Kotah-Dam. The rhizomes are extensive and the plant can be used in soil conservation. *Fl.* & *Fr.*: August-December.

Oropetium villosulum Stapf ex Bor (83617). Rare; found in dry habitats, chiefly in rock crevices near Darah. *Fl.* & *Fr.*: August-October.

Pennisetum polystachyon (Linn.) Schult. (74456, 83778, 90153). Native of tropics of old world. Common in dry wastelands, particularly near Manoharthana, Atru and Kotah-Dam. *Fl.* & *Fr.*: Major part of the year.

Setaria pallide-fusca (Schumach.) Stapf (74481 74827). Occasional, abundant near ponds and ditches near Kotah-Dam, Manoharthana and Darah. Very close to *S. glauca* Beauv. which has, however, keeled upper lemmas. *Fl.* & *Fr.*: August-November.

Sorghum purpureo-sericeum (Hochst. ex A. Rich.) Aschers. (83684). Occasional; grows in dry habitats, chiefly at the foot of hills near Eklera. *Fl.* &*Fr.*: August-October.

Besides these, *Cassia phyllodinea* R. Br. (Caesalpiniaceae), a native of S. Australia, has been collected from the Central Arid Zone Research Institute, Jodhpur (*Maheshwari* 74176 LWG.). *Glossostigha spathulatum* (Hook. ex Wight) Arn. ex Benth. (83753; locality: Atru

village) and *Ranunculus sceleratus* Linn. (90997; locality: Kotah) growing in the present area have not been reported from any part of Rajasthan except Mount Abu. This indicates close affinity of the flora of area with Mt. Abu, the highest peak of Aravallis.

Duthie (1903-29) included the present area in his "Flora of Upper Gangetic Plain", but has not recorded the occurrence of plants from these districts. A perusal of literature on the vegetation of Gangetic Plain reveals that following 17 species have not been previously reported in the flora of Upper Gengetic Plain from this area; these species are: *Ammi majus* Linn., *Plantago pumila* Willd., *Eragrostis papposa* (Duf.) Steud., *Sporobolus tenuissimus* (Schrank.) Ktze., *Oropetium villosulum* Stapf, *Pennisetum polystachyon* (Linn.) Schult., *Brachiaria eruciformis* (Smith) Griseb., *B. setigera* (Retz.) Hubb., *Sorghum purpureo-sericeum* (Hochst.) Aschers., *Ischaemum pilosum* (Klein ex Willd.) Wight, *Dichanthium aristatum* Poir., *Arthraxon hispidus* (Thunb.) Makino, *Vernonia albicans* (Wall.) DC. (74614; locality: Kotah), *Argyreia sericea* Dalz. (74664; locality: Kotah Dam), *Nicotiana alata* Link & Otto (74010; locality: Bundi), *Fleurya interrupta* (Linn.) Gaud. (90522; locality: Kotah) and *Cassia phyllodinea* R. Br. which has been very recently introduced in this country.

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39. DESMIDS OF MARATHWADA, MAHARASHTRA

The algae of Marathwada division of the Maharashtra State have not been studied so far. I collected 327 vials of algae from Aurangabad, Pali, Bhir, Osmanabad, Parbhani and Nanded from Marathwada region during October 1969. The rainfall for the different places of collections varies from 50 to 150 cm. The pH of the water of the collection spots was determined by using B.D.H. Universal indicator and is mentioned in the bracket immediately after the collection spots in the habitats. Camera lucida diagrams of all these algae have been drawn.

In this note, sixty-one desmids belonging to the genera *Gonatozygon, Pleurotaenium, Closterium, Cosmarium, Euastrum* and *Staurastrum* are recorded for the first time. *Closterium leibleinii* Kuetz., *Cosmarium formosulum* Hoff., *C. laeve* Rabenh., *Euastrum spinulosum* Delp. and *Staurastrum gracile* Ralfs are the common taxa in this region.

Gonatozygon monotaenium de Bary

In Moti talao (8.5), Jalna.

The cells are sometimes bent.

Pleurotaenium trabecula (Ehrenb.) Naeg. v. **rectum** (Delp.) W. et G. S. West

In Moti talao (8.5), Jalna. Common in a pond (8.8), Osmanabad. In a puddle (8.4), Nanded.

Closterium incurvum Breb.

Rare. In Harsool lake (8.5), Aurangabad.

C. kolhapurense Kamat v. **minus** Kamat

In side pools, Khadkali stream (8.7), Pali.

C. leibleinii Kuetz.

In a side pool, Khadkali stream (8.7), Pali. In Bindusara stream (8.7), Bhir. In Harsool lake (8.5), Aurangabad. In a pool (8.4), Nanded.

C. littorale Gay

In Harsool lake (8.5), Aurangabad.

C. parvulum Naeg.

In a pond (8.8), Osmanabad. In Harsool lake (8.5), Aurangabad. In Kundlika stream (8.3), Jalna. In a streamlet (8.2), Parbhani.

C. subulatus (Kuetz.) Breb.

In a pond (8.8), Osmanabad.

C. tumidulum Gay

In Moti talao (8.5), Jalna. In Kundlika stream (8.3), Jalna. In Bhogavati stream (8.4), and in a pond (8.8), Osmanabad. In a puddle (8.2), Parbhani.

C. venus Kuetz.

In Moti talao (8.5), Jalna. In a dirty water pool (8.4), and in Harsool lake (8.5), Aurangabad.

Cosmarium abbreviatum Racib.

In a ditch (8.6), and in Bhogavati stream (8.4), Jalna.

C. abbreviatum Racib. f. **pygmaea** Messik.

In Harsool lake (8.5), Aurangabad.

C. angulosum Breb.

In Moti talao (8.5), Jalna. In a pond (8.8), Osmanabad.

C. angulosum Breb. v. **concinnum** (Rabenh.) W. et G. S. West

In Bindusara dam (8.7), Bhir.

C. auriculatum Reinsch

Common in Moti talao (8.5), Jalna.

C. connatum Breb.

In Moti talao (8.5), Jalna.

C. contractum Kirchner v. **minutum** W. et G. S. West

Common in Harsool lake (8.5), Aurangabad.

C. formosulum Hoff.

Common. In Moti talao (8.5) and in Kundlika stream (8.3), Jalna. In Bhogavati stream (8.4), Osmanabad. In Harsool lake (8.5), Aurangabad. In Bindusara stream (8.7), Bhir. In a pool (8.4), Nanded.

C. garrolense Roy et Bisset
In Moti talao (8.5), and in Kundlika stream (8.3), Jalna. In a pond (8.8), Osmanabad. In Harsool lake (8.5), Aurangabad. In a pool (8.4), Nanded.

C. geometricum W. et G. S. West
In Moti talao (8.5), Jalna.

C. hammeri Reinsch
In Khadkali stream (8.7), Bhir.

C. hammeri Reinsch v. **protuberance** W. et G. S. West
Common in Harsool lake (8.5), Aurangabad.

C. hammeri Reinsch v. **subbinale** Nordst.
Rare in Moti talao (8.5), Jalna. Common in a pond (8.8), Osmanabad.

C. immpressulum Eflv. v. **alpicolum** Schmidle
In a cement cistern (8.6), Aurangabad.

C. incertum Schmidle f. **consociatum** Croadale
Common in Harsool lake (8.5), Aurangabad. In Moti talao (8.5), Jalna.

C. laeve Rabenh.
Very common in streams, pools, puddles, ponds (8.3-8.8), Jalna, Bhir, Pali, Aurangabad, Nanded, Parbhani, Osmanabad.

C. laeve Rabenh. v. **depressum** Croasdale
In Bindusara dam (8.7), Pali.
The cells are 10-10.5 μ long, 10 μ broad and isthmus 3-3.2 μ broad.

C. laeve Rabenh. v. **pseudooctangulare** Fritsch et Rich
In Khadkali stream (8.7), Pali.

C. latereprotractum Playfair
In Moti talao (8.5), Jalna.

C. majae Strom
In Moti talao (8.5), Jalna.

C. margaritatum (Lund) Roy et Bisset
In Moti talao (8.5), Jalna. In a pond (8.8), Osmanabad.

C. meneghinii Breb.
In Kundlika stream (8.3), Jalna.

C. moniliforme (Turp.) Ralfs v. **limneticum** W. et G. S. West
In a puddle (8.5), Aurangabad.

C. muelleri Schmidle
In Kundalika stream (8.3), and in Moti talao (8.5), Jalna. In a pond (8.8), Osmanabad. In a puddle (8.4), In Harsool lake (8.5), Aurangabad. In a puddle (8.2), Parbhani.

C. nitidulum de Not
In Harsool lake (8.5), Aurangabad.

C. obtusatum Schmidle
In Bindusara stream (8.7), Bhir.

C. orthostichum Lund
In Harsool lake (8.5), Aurangabad.

C. pardalis Cohn
In Moti talao (8.5), Jalna. In a pond (8.8), Osmanabad.

C. portianum Archer
Rare in Moti talao (8.5), Jalna.

C. pseudobroomei Wolle
In Moti talao (8.5), Jalna.

C. pseudoexiguum Racib. v. **retusum** Hirano
Rare in Harsool lake (8.5), Aurangabad.

C. quinarium Lund
In Kundlika stream (8.3), Jalna.

C. regnellii Wille
Common in Harsool lake (8.5), Aurangabad.

C. regnellii Wille f. **minima** Eichl. et Gutw.
In Harsool lake (8.5), Aurangabad.

C. regnellii Wille v. **kerguelense** Krieger et Gerloff
Common in Moti talao (8.5), Jalna. In a pond (8.8), Osmanabad. In Harsool lake (8.5), Aurangabad. In a puddle (8.4), Nanded.

C. sexangulare Lund
In a pond (8.8), Osmanabad.
The present alga is slightly bigger up to 45 μ long.

C. speciosum Lund v. **simplex** Nordst.
In Moti talao (8.5), Jalna. In Bhogavati stream (8.4), Osmanabad.

C. spinuliferum W. et G. S. West
In a pond (8.8), Osmanabad.

C. subglobosum Nordst.
(= *Actinotaenium subglobosum* (Nordst.) Teiling)
Very common in Bhogavati stream (8.4), Osmanabad.

C. subtumidum Nordst.
Rare in a pond (8.8), Osmanabad. In Moti talao (8.5), Jalna.

C. submamillatum W. et G. S. West
In Harsool lake (8.5), Aurangabad.

C. subspeciosum Nordst.
Very common in cement cistern (8.5), Aurangabad.
The zygospores are globose (32-34 μ in diameter) with short blunt projections.

C. subspeciosum Lund. v. **validius** Nordst.
In a side pool of Khadkali stream (8.7), Pali.

C. transiens Gay
Common in Bindusara stream (8.6), Bhir.

C. triplicatum Wolle
In Moti talao (8.5), Jalna.

C. undulatum Corda ex Ralfs v. **minutum** Wittrock
Common in Harsool lake (8.5), Aurangabad.

Euastrum spinulosum Delp.
Common. In Moti talao (8.5), and in Kundlika stream (8.3), Jalna. In Bindusara stream (8.7), and Bindusara dam (8.7), Pali and Bhir. In puddles (8.4-8.6), Aurangabad, Nanded and Parbhani.

Staurastrum gracile Ralfs
In Moti talao (8.5), Jalna. In Harsool lake (8.5), Aurangabad. In puddles (8.4-8.6), Parbhani, Nanded and Aurangabad.

S. iotanum Wolle v. **tortum** Teiling
In Kundlika stream (8.3), Jalna.

S. muticum Breb.
Common in a ditch (8.5), Jalna.

S. punctulatum Breb. v. **ellipticum** Lewin
In a pond (8.8), Osmanabad.

N. D. KAMAT[1]

BOTANY DEPARTMENT,
INSTITUTE OF SCIENCE,
NAGPUR,
July 28, 1973.

40. ON THE OCCURRENCE OF *URTICA URENS* LINN. IN INDIA

While making plant collections from Patiala district (Punjab), I noticed on 24-iii-1971 some small plants growing by the wayside in Baradari Gardens, Patiala. The mild sting caused by the plant while uprooting it gave a hint of the identity of the family (Urticaceae) to which the plant belongs. The genus was identified as *Urtica*. Some plants were again collected on 21-iii-1973 from the lawns of the same locality. The species was identified as *Urtica urens* Linn. at Central National Herbarium, Howrah. To the best of my knowledge the plant has not been reported earlier from India and is a new record for this country. The plant makes its appearance in the lawns and waste places in Baradari Gardens, Patiala during spring. Specimens collected (M. Sharma 2283 and M. Sharma 3543) have been deposited in the Herbarium of Punjabi University, Patiala.

---

[1] *Present address*: Associate Professor of Botany, Institute of Science, Kile Ark, Aurangabad 431 001.

Urtica urens Linn. Sp. Pl. 984, 1753; Bentham, Handbook of the British Flora 464, 1858; Hooker, The Student's Flora of the British Islands 350, 1878; Boissier, Flora Orientalis 4: 1146, 1879; Moss, The Cambridge British Flora 2: 100, t. 108, 1914; Butcher, A New Illustrated British Flora (Pt. 1) 945, 1961; Clapham, Tutin & Warburg, Flora of The British Isles 561, 1962.

Erect, little-to much-branched annual; stems about 10-60 cm long, glabrous except for the stinging hairs. Leaves opposite, stipulate, long petioled, petiole about 1.5-2.0 cm long; lamina ovate-oblong or elliptic-ovate, rounded or truncate at the base, about 3.0-4.5 cm long and about half as broad, deeply and often irregularly serrate, teeth few, terminal oblong, acute. Inflorescence branched from the base, branches usually in pairs and shorter than petioles, ascending or spreading; male and female flowers intermixed in small, loose, almost sessile clusters on the branches; the female more numerous than the male. Male: Perianth 4-partite, lobes concave, imbricate in bud; stamens 4; anthers reniform. Female: Perianth 4-partite, segments unequal, flat. Stigma subsessile, penicillate. Fruit compressed and embraced by the persistent perianth.

Specimens collected by me differ from the normal description in being unbranched. This is probably due to the dry and unfavourable conditions in which the plants were growing.

In FLORA OF BRITISH INDIA *5*:548, 1888, J. D. Hooker has described 3 species of *Urtica*. All are perennial and occur on hills above 1,500 m. Out of these *U. dioica* Linn. is dioecious. *U. parviflora* Roxb. is a much taller plant, 90-150 cm in height with larger 5-10 cm × 2·5-6 cm leaves. Moreover, flower clusters are on the branches of loosely spreading panicles. The third species, *U. hyperborea* Jacq. is much likely to be confused with *U. urens* Linn. due to the similar size of the branches and leaves, and short crowded cymes. But the former is an alpine plant reported from Tibet occurring at the altitude of 4 to 5000 m and can be easily separated from the latter by its low, tufted branches woody below and pubescent between the stinging hairs, and subsessile leaves which are glandular-puberulous beneath.

Common Name: Small stinging Nettle (Britain).

DISTRIBUTION: Europe, N. Africa, Siberia, W. Asia. Introduced in N. America. The plant is a native of Britain.

Flowers and Fruits: March-April.

ACKNOWLEDGEMENTS

I am grateful to Prof. S. S. Bir for providing facilities. Thanks are also due to U.G.C. for providing travel grant to visit Calcutta and to Deputy Director, Central National Herbarium, Howrah for providing herbarium facilities.

DEPARTMENT OF BOTANY,
PUNJABI UNIVERSITY,
PATIALA, (PUNJAB),
August 7, 1973.

M. SHARMA

41. SOME NOTEWORTHY PLANT SPECIES FROM GORAKHPUR

During our study of the flora of Gorakhpur district, we came across a number of species which are new to the area. Of these, the following ten species are new records for the flora of Upper Gangetic Plain.

Cleome rutidosperma DC. Prodr. 1 : 241, 1824
= *C. ciliata* Schum. & Thonn. Dansk. Vidensk. Selsk. Skr. Nat. Mat. Afh. 4:68, 1829, ex Char.

Crotalaria pusilla Heyne ex Roth, Nov. Sp. Pl.: 335, 1821; Fl. Brit. India 2 : 70; Bot. Bihar & Orissa: 231.

Dentella serpyllifolia Wall. ex Airy shaw in Kew Bull.: 289, 1932.
= *D. repens* (Linn.) Forst. in Fl. Brit. India 3:42, 1880, pro- parte.

Dysophylla stellata Benth. in Wall. Pl. As. Rar. 1:30, 1829; Fl. Brit. India 4:640; Cook, Fl. Bombay 2:540.

Hyptis suaveolens (Linn.) Poit. in Ann. Mus. Par. 7:472, t. 29. f. 2, 1806: Fl. Brit. India 4:630; Bot. Bihar & Orissa 4:736.
= *Ballota sauveolens* Linn. Syst.: 1100, 1759.

Bulbostylis capillaris (Linn.) Clarke in Fl. Brit. India. 6:652: Bot. Bihar & Orissa 5:924.
= *Scirpus capillaris* Linn. Mant.: 312, 1771.

Cyperus cyperoides (Linn.) Kuntze, Rev. Gen. Pl. 3 (2): 333, 1898.
= *Scirpus cyperoides* Linn. Mant.: 181, 1771.
= *Mariscus sieberianus* Nees ex Clarke in Fl. Brit. India 6:622, 1893; Bot. Bihar & Orissa 5:909.

Cyperus thomsoni Boeck. in Linnaea 46:295, 1870; Fl. Brit. India 6:608; Bot. Bihar and Orissa 5:899.

Eleocharis congesta D. Don, Prodr. Fl. Nep.: 41, 1825; Fl. Brit. India 6:630; Bot. Bihar and Orissa 5:913.

Rhynchospora hookeri Boeck. in Linnaea 37: 621, 1873; Fl. Brit. India 6:671; Bot. Bihar and Orissa 5:930.

ACKNOWLEDGEMENT

We are grateful to Professor K. S. Bhargava, Head of the Department of Botany, University of Gorakhpur for providing necessary facilities for the present study.

DEPT. OF BOTANY,
PATNA UNIVERSITY,
PATNA 800 005.

M. O. SIDDIQUI

DEPT. OF BOTANY,
UNIVERSITY OF GORAKHPUR,
U.P.,
August 26, 1970.

S. N. DIXIT

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Editors

J. C. DANIEL, P. V. BOLE & A. N. D. NANAVATI

DECEMBER 1975

Rs. 35.00

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ERRATA

Volume 72(3) December 1975

Systematic studies on fishes belonging to the Genus **Coilia** Gray, 1831

On page 737, para 4, heading
for **Colia reynaldi** Valenciennes, 1848 *read* **Coilia reynaldi** Valenciennes, 1848

Miscellaneous Note 8. A note on the Swifts (*Collocalia*) found in Burma

On page 848 para 3 heading
for HMALAYAN SWIFTLET *read* HIMALAYAN SWIFTLET

JOURNAL
OF THE
BOMBAY NATURAL HISTORY SOCIETY

1975 DECEMBER Vol. 72 No. 3

A year of Bandipur[1]

H. C. SHARATCHANDRA AND MADHAV GADGIL
Centre for Theoretical Studies, Indian Institute of Science, Bangalore 560 012

(*With twelve figures, and two plates*)

This is a preliminary report of a year's ecological observations at the Bandipur National Park (11° 39′N, 76° 37′E) in Karnataka. Bandipur is a dry deciduous forest dominated by *Anogeissus latifolia* and *Tectona grandis*. The study area of 23 sq km supported a population of 800 chital (*Axis axis*), 90 elephants (*Elephas maximus*), 20 sambar (*Cervus unicolor*), 40 wild dogs (*Cuon alpinus*), over 10 panthers (*Panthera pardus*) and 10 or fewer tigers (*Panthera tigris*) and a small number of gaur (*Bos gaurus*), barking deer (*Muntiacus muntjak*), wild pig (*Sus scrofa*), and sloth bear (*Melursus ursinus*).

The main rutting season of chital is from May to August, the majority of fawns being dropped between December and February. The death rate of chital is estimated at 92 per cent for the first year and 25 per cent per year thereafter. The fertility rate is estimated at one fawn per adult female per year. Chital form large herds of more than hundred individuals during the monsoon, but these break up into smaller herds of five or six during the dry season. Changes in the herd size of elephants follow a similar pattern. The hunting behaviour of wild dog, which is the major predator of chital is described.

[1] Accepted August 1975.

Introduction

This is a preliminary report of a year's ecological observations at Bandipur. The Bandipur National Park (11°40′-11°55′ N and 76°7′-76°52′ E), covering an area of 689.5 sq km lies at the heart of an extensive forest at the confluence of Western Ghats and Nilgiris. Geologically this area is a part of the archaean crystalline rock formation of the southern part of peninsular India. The terrain is gently undulating with hills rising upto 1500 metres from a basal plateau at an altitude of 1000 metres. The Nilgiri range of hills begins just south of Bandipur, and rises steeply to a height of over 2000 metres within a distance of 25 kilometres.

The National Park of Bandipur is part of a continuous forested tract which includes the wild life sanctuaries of Nagerhole, Wynaad and Mudumalai and the reserved forests of Moyar, Hasanur and the Biligirirangan Temple Hills. The annual precipitation in this tract varies from 3000 to 1000 mm and the forest types consequently range from moist evergreen to dry deciduous. The precipitation at Bandipur itself is only around 1000 mm and the vegetation is largely dry deciduous. This entire forest is very rich in wild life, with elephants, gaur, sambar, chital, barking deer, four-horned antelope, sloth bear, wild pig, grey langur, wild dog, panther and tiger occurring almost throughout the tract. All of these species occur in Bandipur National Park as well, the elephants and chital being particularly abundant.

The present account is based on a year's field work at the Bandipur National Park from May 1, 1974 to April 31, 1975. One of us (HCS) has spent the entire period in field in Bandipur except for a few occasional absences of less than a week. The only exception to this was in June 1974, when a period of three weeks was spent outside Bandipur National Park in visiting the adjacent forests. The second investigator (MG) has spent an average of eight days a month at Bandipur throughout the year. Early morning and late afternoon hours are regularly spent in field observations, totalling three to four hours each day. The work is mostly carried out on foot and the area of intensive observation is therefore restricted to a few square kilometres around Bandipur Lodge. The total study area is *c.* 23 sq km out of the 689.5 sq km area of the park and most of this area is visited twice a week an hour or two at a time in the sanctuary vehicle (fig. 1). Some observations have also been made from elephant back.

Habitat

There is no accurate record of the climate of Bandipur. The bioclimate of the Park has been classified as of the tropical moderate type

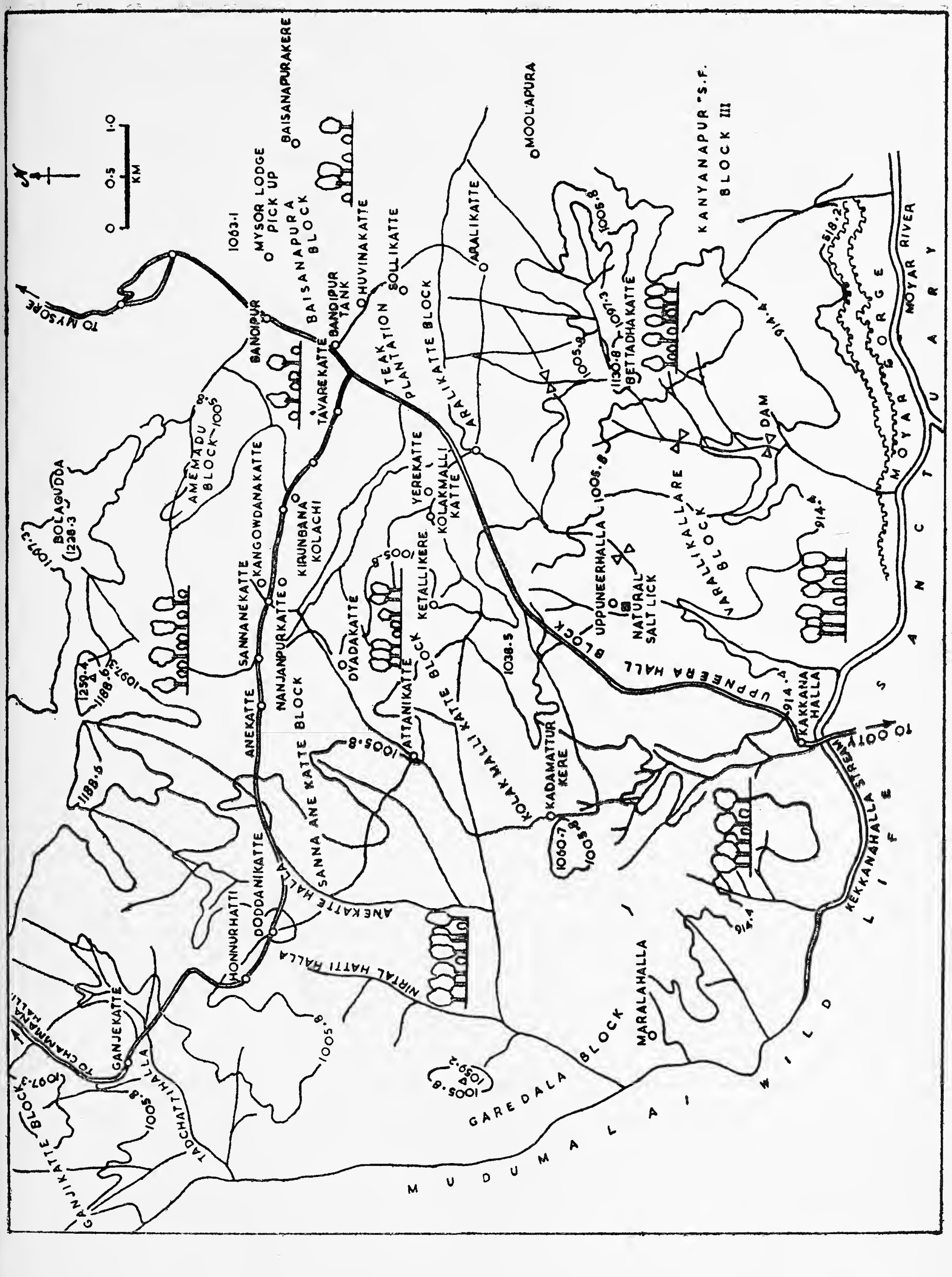


Fig. 1. Map of the area around Bandipur lodge in which most of the field work was conducted. The vegetation profiles diagrammatically represent the height, form and the extent of tree and shrub growth.

(Gaussen, Legris & Viat 1969). The mean annual temperature is less than 24°C and the annual precipitation about 1000 mm, with a range of variation between 750 and 1250 mm. There are heavy pre-monsoon showers in April and May, followed by moderate rains up to September, and another series of heavy showers in October and November.

The vegetation in the study area of 23 sq km belongs to two broad types. The northern half has trees of medium height (10 to 15 metres) with an open canopy and considerable undergrowth (see fig. 2). The major tree species of this locality include *Anogeissus latifolia, Terminalia tomentosa, Phyllanthus emblica, Butea monosperma, Tectona grandis, Terminalia bellerica, Xeromphis spinosa* and *Lagerstroemia parviflora*. The extensive undergrowth is made up of *Lantana camara, Dendrocalamus strictus, Gevotia* spp., *Toddalia asiatica, Argeria cuneata, Asparagus racemosus* and *Cryptolepis buchnani*. The grasses mostly belong to the genera *Heteropogon* and *Themeda*.

There is a sharp north-south gradient of rainfall within the study area, the precipitation increasing as one approaches the steep climb of Nilgiris towards the south. The southern half of the forest therefore enjoys more rainfall and is more moist. The trees are taller, between 15 to 25 metres in height; the canopy cover is more complete, and the undergrowth much reduced. The major tree species include *Anogeissus latifolia, Tectona grandis, Terminalia tomentosa, Dalbergia latifolia* and *Albizzia odoratissima*. There are several major streams in this area, and the stream banks are frequented by *Mangifera indica* and *Bambusa arundinacea*. The shrubby growth is also largely restricted to the stream banks and includes *Lantana camara, Dechaschistia crotonifolia* and *Argeria cuneata*.

In addition to these two major vegetation types merging into each other, there is an extensive open grassy meadow of two square kilometres with scattered scrub and trees near the Tavarekatte area. This has undoubtedly been created in the past through human interference. The species composition is no different for this area except that there are a few patches of the exotic weed *Eupatorium* in the clearing.

The annual cycle of plant growth starts at Bandipur in March and April with pre-monsoon showers, with the grasses coming up and a number of trees sprouting leaves. The grasses dry up after the first flush of growth during the dry spells that follow the first rains. By early May there is enough precipitation for a vigorous growth of grasses and a full production of leaves. This phase of growth continues until October when the grasses begin to seed. With this and the onset of dry season in late November, the availability of herbaceous matter for grazing declines drastically. The trees flower in the dry season, beginning with

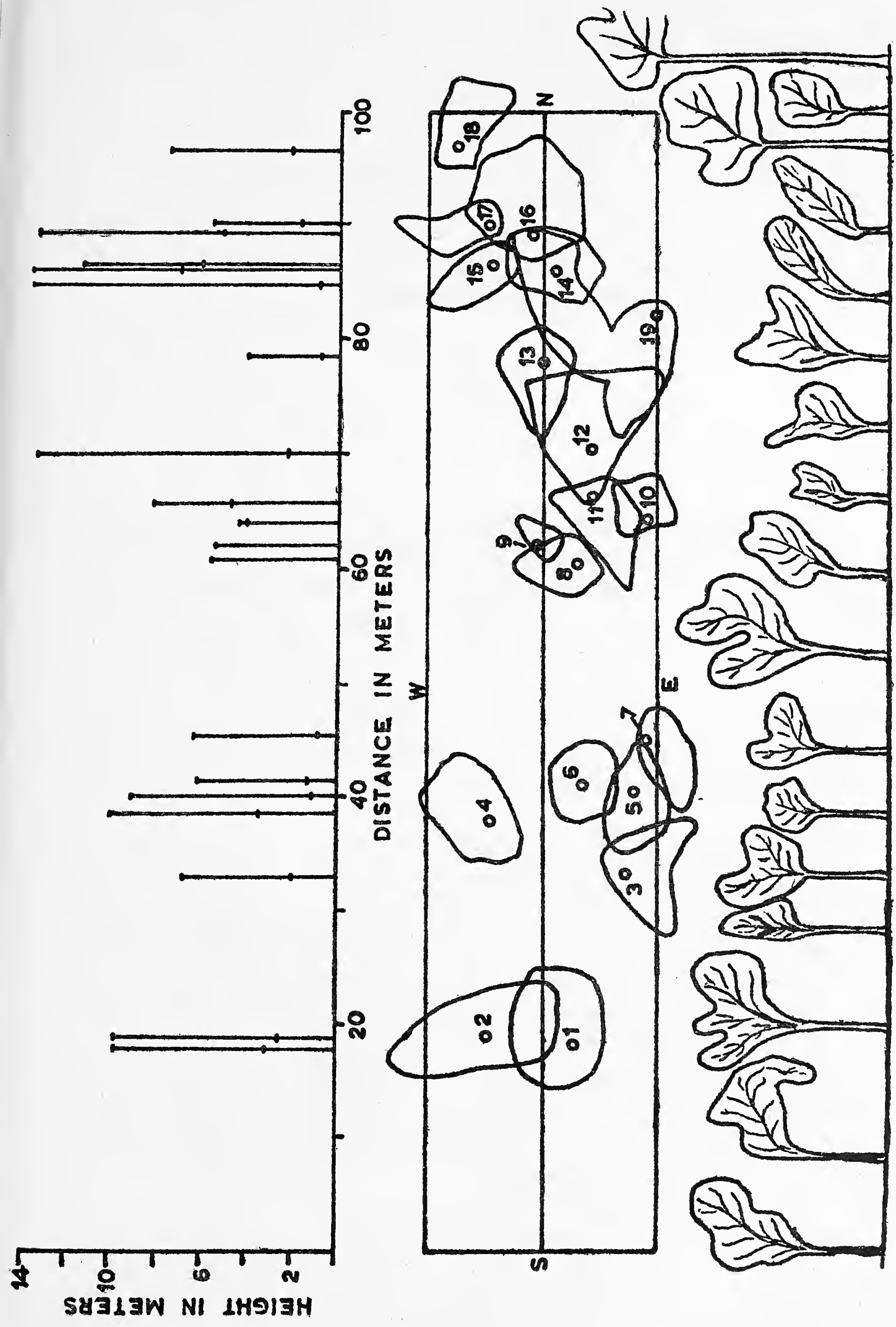


Fig. 2. The vertical profile, the horizontal projection and the form of the trees in a sample area of 100 × 20 metres in the northern part of the study area.

Butea monosperma in November. Several important fruits consumed by the herbivorous animals such as *Phyllanthus emblica, Terminalia bellerica* and *T. chebula* are produced in the dry season. The forest fires, mostly set deliberately begin in January and burn grass over very extensive areas. With these forest fires begins a period of acute food shortage for the herbivores. This is temporarily alleviated by the sprouting of grass with the first showers in March. The dry spells in March-April however bring in serious food scarcity once again. This finally ends only with the persistent good showers in late April and by early May there is plenty of good grass for grazing.

CHITAL

Habitat preference:

The chital or spotted deer (*Axis axis*) is by far the most conspicuous mammal of Bandipur. Hundreds of them may be seen right within the lodge grounds throughout the night. The habitat of these animals is characteristically the ecotone between the forest and the open grassland. They take much less to the thicker forest with a closed canopy. They also stick to the plains and tend to avoid hilly terrain. Associated with this preference for open grassy glades in forest is their marked preference for grass over browse for feeding, and a tendency to rely on social warning mechanisms rather than camouflage for predator avoidance.

The most extensive grassy patches at Bandipur occur in the region from Tavarekatte to the lodge and the largest concentrations of chital occur in an area of a radius of 2 km in this part of the park. This concentration seems to be made up of four sub-populations, namely (i) two populations around Tavarekatte (ii) one to the southeast of Bolagudda and (iii) one around Ministergutti. The second largest population is also associated with extensive grassy patches near Sollikatte. Two smaller populations occur to the north of Kekkanahalla, and around Kolakmallikatte where the grassy areas are limited in extent (see Table 1). Chital is a very sedentary animal and the deer from each of these areas restrict their movements to a circle of a radius of 1.5 to 2 kilometres.

Table 1 gives our estimate of the total population of chital over the study area of 23 sq km as 800, or a density of 36 individuals per sq km. Following Eisenberg & Lockhart's (1972) estimate of 45 kg as the average weight of a chital, this gives a biomass of 1620 kg per sq km. The chital are however non-uniformly distributed over the total study area, and the Bolagudda area of 2 sq km harbours a population 170, or at

a density of 85 individuals or 3825 kg per sq km. These estimates may be compared to 135 kg per sq km for Kanha in Madhya Pradesh, 263 kg per sq km for Wilpattu in Sri Lanka, and 3960 kg per sq km

TABLE 1

ESTIMATE OF SIZES OF CHITAL POPULATIONS AT BANDIPUR

Locality		Population size
Near Bolagudda		170
Tavarekatte I		150
Tavarekatte II		70
Sollikatte		200
Kolakmallikatte		60
Kekkanahalla		100
Ministergutti		80
	Total:	830

for Corbett in Uttar Pradesh (De & Spillett 1966, Eisenberg & Lockhart 1972, Schaller 1967).

Daily activity cycle:

The daily activity cycle of chital follows the pattern described by Schaller (1967) for the Kanha population with periods of feeding and social activity in the early mornings and late evenings. This population however has the remarkable habit of congregation of daytime feeding herds into much larger night-time aggregations. These aggregations grow from 1700 hours onwards as the deer herds scattered over five or six sq km for grazing move towards their favourite night-time resting spots where they may form compact concentrations of a hundred or more individuals. They split into smaller and smaller grazing herds in the morning from 0600 hours onwards. The night-time resting spots are open grassy areas. Earlier in the study period, the largest of such open areas was provided by the lodge grounds and over 200 deer used to congregate there at night. Considerable clearing of grasses and shrubs was carried out later in the study period for the provision of view lines along the game roads, and as many deer have started spending the night in these clearings, the number of deer coming to the lodge has sharply declined. Regardless of the number coming to the lodge, however, the proportion of males in the night-time aggregations there has been consistently lower than the proportion in the day-time grazing herds (see fig. 3). It then appears that the males have a tendency to remain closer to the grazing grounds.

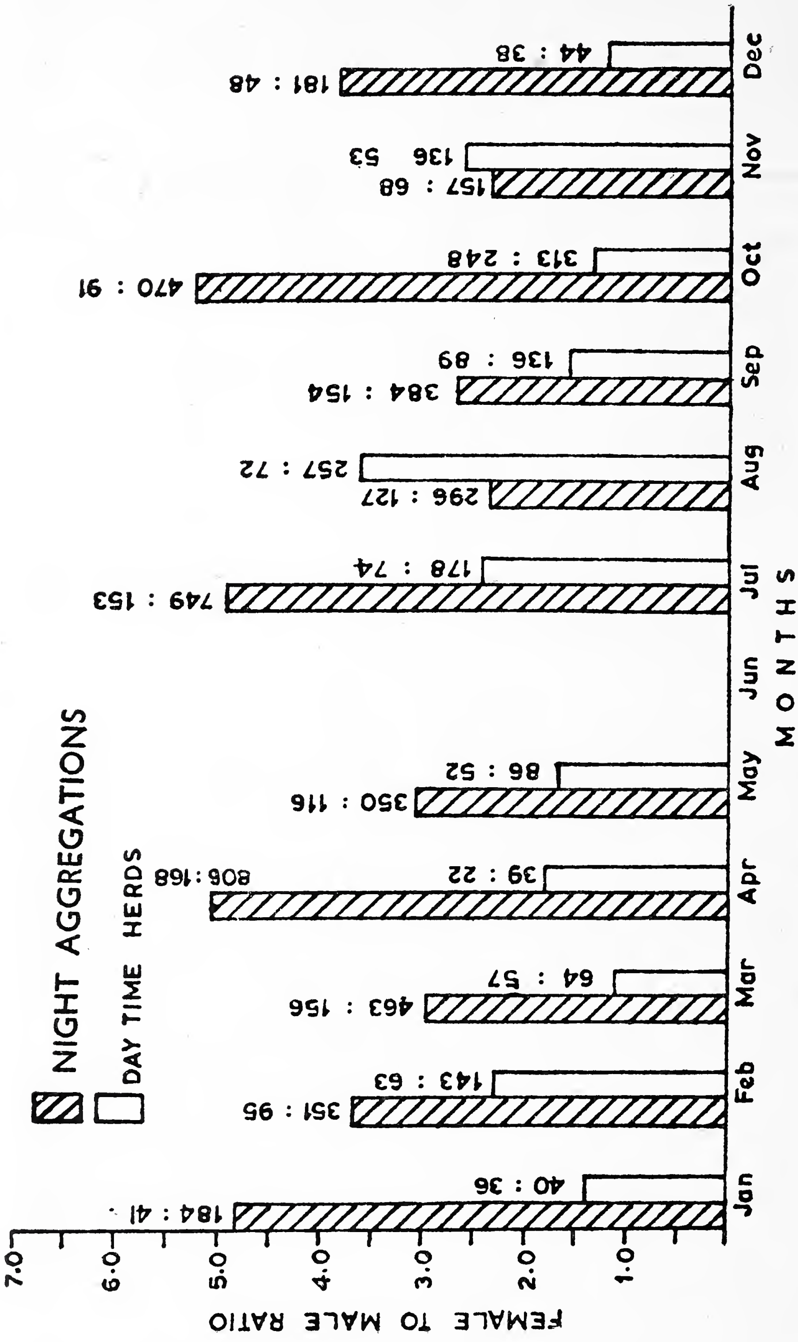


Fig. 3. The female to male ratio in the night aggregations and the day-time herds of chital in various months of the year.

Seasonal cycle:

Feeding

Grasses constitute the preferred food of chital which graze on them even when the grasses are completely dry. They particularly relish the fresh shoots of grasses, and also readily browse on fresh shoots of bamboo, *Lantana, Phyllanthus* and so on. This is supplemented by occasional browsing on a number of other species such as *Acacia arabica, Terminalia tomentosa, Xeromphis spinosa, Butea monosperma, Lagerstroemia parviflora, Barleria retusa, Vitex altissima, Cordia myxa*. It is notable that the chital browse on the highly laticiferous, and to man, poisonous leaves of *Calotropis gigantea*. These leaves are rich in calcium, and this may be the reason for chital selecting them.

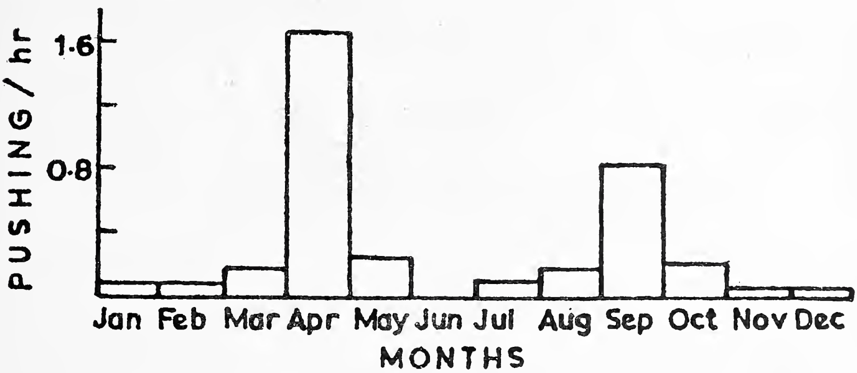


Fig. 4. The number of pushings per hour of observation in the various months of the year for the chital.

As discussed above, the months from May to October provide good grazing on grass and on fresh shoots of various plants. Chital do not have to move much while grazing in this season, and there is little crowding. They graze in large herds, and it appears that their food requirements are rather quickly satisfied, leaving ample time for other social activities. The months from November onwards are difficult with the grasses seeded and drying, and fresh growth of shrubs and trees over. This is however the season of fruiting, and deer feed heavily on fallen fruit. As the season progresses, the food scarcity becomes very acute, especially after the forest fires in January. In this season, particularly from January to March, the deer have to spend a great deal of time looking for food. They move a lot from one bit to another while feeding, and there is much jostling around for food (fig. 4). This jostling is not restricted to males but involves females and fawns as well. They graze in small herds, and seem to spend so much time in feeding that they have little time or energy left for other social activities.

Antler growth

Males of chital grow and shed a set of antlers every year. The cycle probably begins at the age of one year, with the first set of antlers, the spike horns, being less than 25 cm in length. From the second year onwards, they grow a proper set.

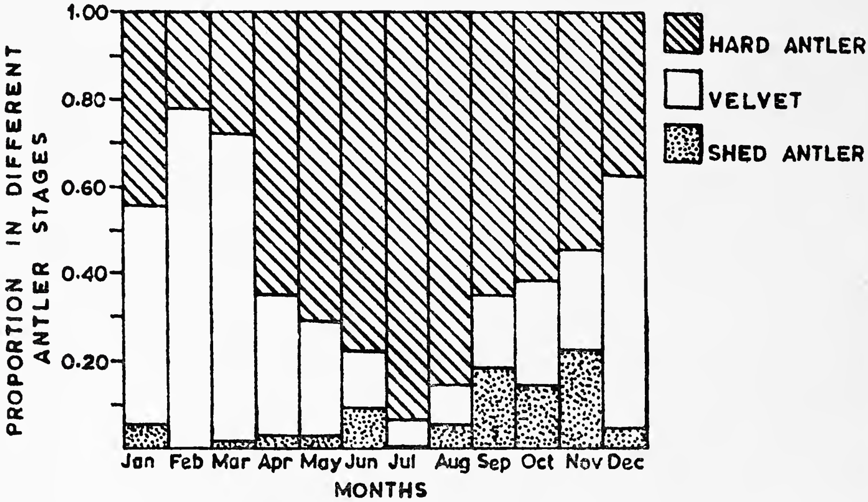


Fig. 5. The proportion of chital males in different stages of antler development for the various months of the year.

Males in all stages of antler development are seen at Bandipur throughout the year. There is nevertheless a distinct seasonality in the development of antlers. As fig. 5 shows, the months of September to November are the months of shedding of antlers, December to February or March are the months of growth of new antlers, and April to August are the months of loss of velvet and a preponderance of hard antlers.

Reproduction:

Males in the hard antler stage are sexually the most active; 90 per cent of all sexual activity is confined to this stage. We would therefore expect the season of marked sexual activity to coincide with the season of the preponderance of males in hard antlers from April to August. As fig. 6 shows, this is in fact the case, and the rutting season of the deer does fall in these months. The gestation period of chital has been variously estimated to range between six to eight and half months. The expected peak of conception from May to July must then result in a peak of fawning between December and February.

Female chital leave the herd around the time of parturition, and keep the fawns hidden in bushes for the first two or three months of their life. The females periodically visit the fawns at this stage to nurse

them, and then leave again to graze on their own. Fawns really join the herds only after two or three months; and hence the proportion of fawns to females in a herd would be at its height only two to three

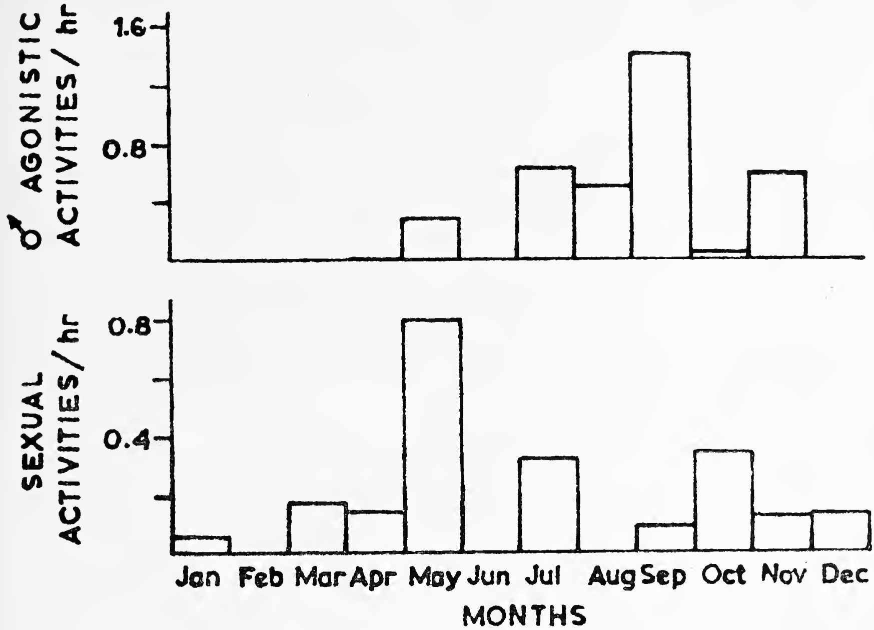


Fig. 6. The number of sexual activities and aggressive interactions amongst the chital males per hour for the various months of the year.

months after their birth. As fig. 7 shows, this peak occurs in the month of April, and must correspond to a peak of births in January-February.

All these data pooled together provide definitive evidence for a seasonality in reproduction of chital. These seasonal trends correspond closely with the trends noted by Schaller (1967) for Kanha and by Graf & Nichols (1966) for Hawaii, and contradict the statement of Krishnan (1972). The seasonality of reproduction must have evolved to fit in with the seasonal changes in the various environmental parameters such as food supply, predation pressure etc. The three critical stages in the life cycle of a mammal are: conception and early foetal development, parturition and nursing of the very young fawn, and weaning and beginning of the independent feeding by the young. These stages centre on the months of July, January and April for the chital of Bandipur. Early foetal development then takes place under good food supply, early nursing under great food scarcity, and weaning of the young just as the tender shoots of grass appear in abundance. This would obviously be optimal if the first and the third stages are the most critical. A final resolution of this issue obviously requires much more investigation.

Predation:

Chital are preyed upon by wild dog, panther, tiger and domestic dog. We have noticed chital hair in the droppings of all four predators. Judging from the quantity of droppings seen, the wild dog is the most significant predator of chital. It preys on all age classes and both sexes of the deer.

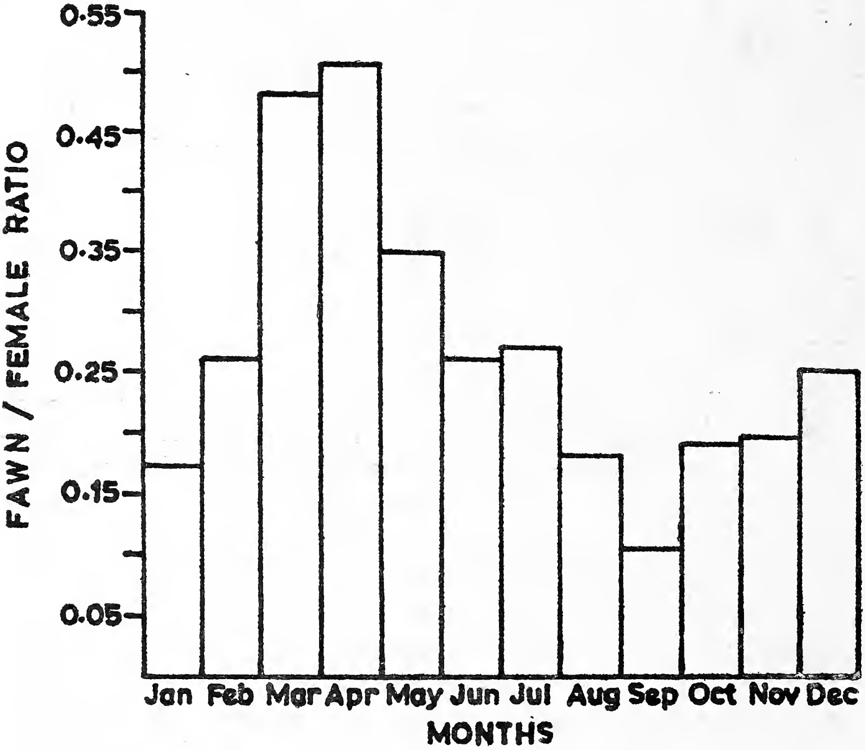


Fig. 7. The ratio of fawns to females in chital for the various months of the year.

Chital respond to the presence of the wild dogs by signalling alarm by raising their tails and then by bunching together. These tight herds start moving slowly away while keeping the wild dogs constantly in view. The chital do not break into a run until the final charge of the wild dogs. When caught, the victim gives out a long drawn wailing call. Even at this point, the chital do not move more than a few hundred metres from the site of the kill. They may then graze apparently totally unconcerned while the wild dogs are feeding on the kill.

Stags with good heads of antlers also fall victim to wild dogs and do not appear to resist in any way. When in a herd, they are the first to run and get into the middle of a herd safely surrounded by females and fawns on all side. One male with hard antlers about 80 cm in length died of drowning in the Tavarekatte pond while trying to escape

wild dogs with one of its eyes injured and with a wound in its hind quarters.

Sex and age composition:

The chital population shows a sex ratio biased in favour of females for most of the months (see fig. 8). In some cases the bias is extreme and is likely to be due to a misclassification of immature males or of adult males in shed antler state as females. Such misclassification is especially likely in large moving herds. In addition, the bias in favour of females may also result from a higher mortality rate amongst the males.

There are two sources of information on the age structure of the chital population. Juveniles less than nine month old are distinguishable as such on the basis of size, although there is room for error. Males growing antlers for the first time at the age of one year grow a distinct type of antlers known as 'spike' antlers. The proportion of the spike males in the population is a reliable estimate of the frequency of the age class of one year. At its highest the fawn to female ratio is a little over 0.5 in April. This compares favourably with the value of 0.68 for Kanha and 0.27 for Corbett. As our estimate of the proportion of females is probably too high, 0.5 may be taken as a minimal estimate. This ratio reaches its lowest value of 0.1 in the month of September (fig. 8). The proportion of spike males in the total adult male population has the maximum value around 0.25 to 0.3.

Mortality rate

The proportion of fawns to the females drops from 0.5 in April to 0.1 in September. As there appear to be extremely few new fawns dropped between April and September we may estimate the mortality over these six months at 0.8, or at the rate of 0.26 per month. As explained above, the fawns are probably born two or three months before April and are mostly kept hidden in bushes. If we assume the mortality to have been around 0.26 per month for these months also, we have the total mortality over the first nine months as 0.91.

The proportion of one year olds in the adult male population has been estimated at 0.25 to 0.3 from incidence of spike males. Now if we assume the survival rate to be constant at some value p throughout the adult life, and the population N to be stable, the proportion of one year olds in the population is:

$$N/N \sum_{x=o}^{\infty} p^{x} = 1 - p$$

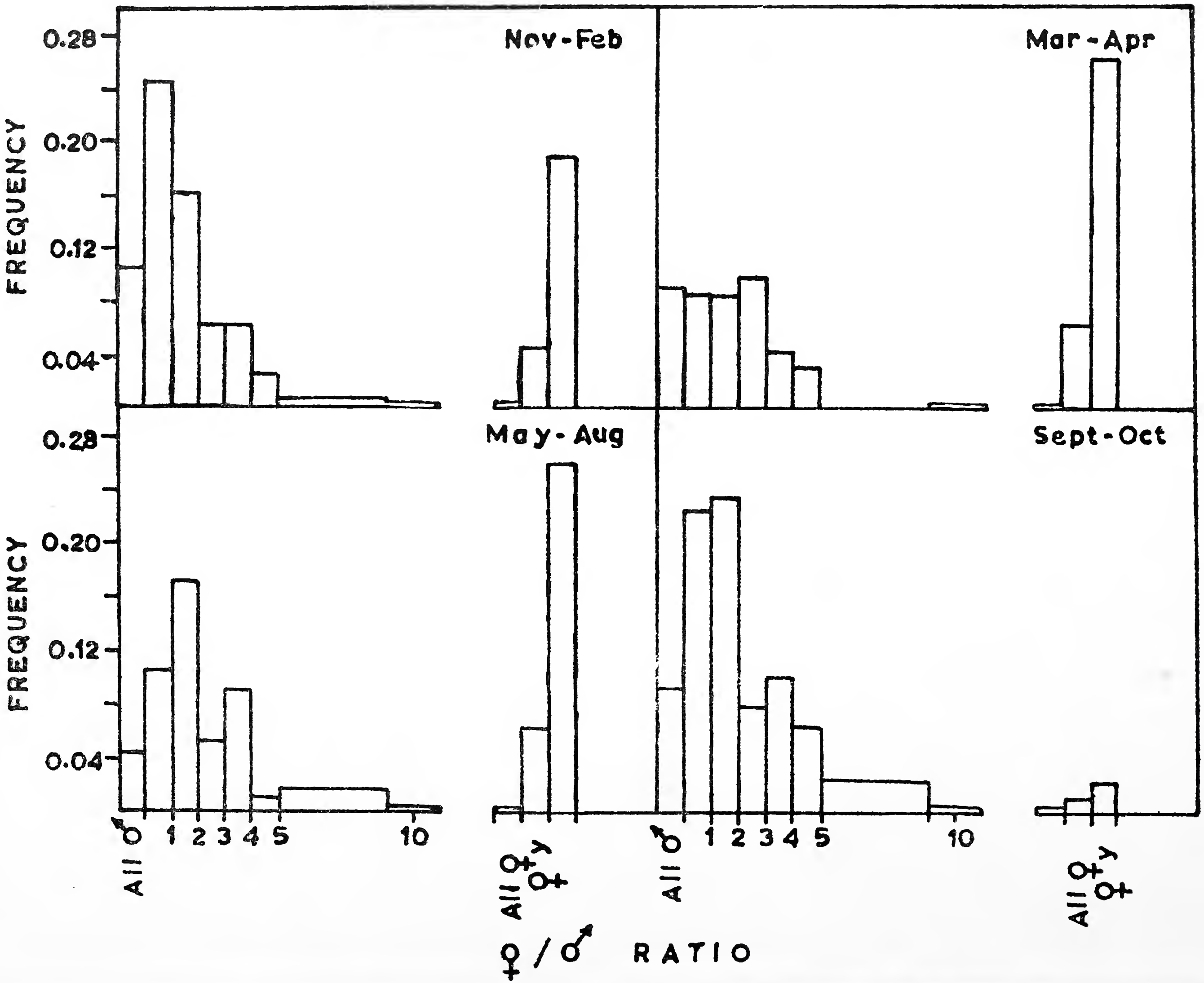


Fig. 8. The sex and age composition of the chital herds at different times of the year ♂ = male, ♀ = female, y = young, ♀y = A herd composed of females and young only.

This gives the estimate of adult mortality rate at 0.25 to 0.3 per year. Assuming this to be the rate of mortality beyond the age of nine months, we get the mortality rate for the first year as 0.92.

Fertility rate

Chital females in captivity start breeding at an age as early as six months and are capable of breeding at intervals of eight months after that. The very distinct peak of fawning at Bandipur however indicates that the females here breed roughly at the interval of one year. Most of the nursing females are accompanied by a single fawn, and twins appear to be extremely rare. Our computation of mortality of fawns suggested a rate of 0.26 per month. The mortality over the first three months may then be estimated roughly at 0.5. The ratio of 0.5 of fawns presumed to be three months old in April to females must then derive from an original ratio of one fawn at birth per adult female. We thus estimate the fertility rate to be one fawn per adult female per year, or assuming an equal sex ratio at birth 0.5 female fawns per adult female per year.

Population growth rate

The growth rate λ of a population may be calculated by solving:

$$1 = \sum_{0}^{\infty} \lambda^{-x}\, l_x b_x$$

where l_x is the probability of survival to age x and b_x is the number of female offspring produced by a female of age x.

Our estimates are $l_1 = 0.08$ and $l_x = 0.08x\ (0.75)^{x-1}$ for $x \geqslant 1$, and $b_x = 0.5$ for $x \geqslant 1$. We may mention $l_0 = 1$ and $b_0 = O$ for the sake of completeness. We then have

$$1 = \sum_{1}^{\infty} \frac{0.08\ (0.75)^{x-1}\ 0.5}{\lambda^{x}}$$

$$= \frac{0.08 \times 0.5}{0.75} \sum_{1}^{\infty} \left(\frac{0.75}{\lambda}\right)^{x}$$

$$1 = \frac{0.08 \times 0.5}{0.75} \times \frac{0.75}{\lambda - 0.75}$$

$$\lambda = 0.79$$

The population growth rate λ is thus estimated to be less than 1; i.e. the population appears to be declining. This is of course a first estimate which is subject to a number of errors. Our continuing studies at Bandipur will hopefully enable us to verify its reliability.

Herd size and composition:

Chital is a highly social species, and the animals occur only rarely as solitary individuals. Most of the time they occur in herds of 5-20 individuals, though herds of up to 150 animals are not uncommon. The basic unit of the herd appears to be a female and her daughters and perhaps granddaughters, and grandsons. Adult males are only loosely attached to the herds made up of these matriarchal units. Adult males also occur in bachelor herds, particularly outside the breeding season.

There are marked seasonal differences in the size and composition of these herds (figs. 8 and 9). The herds are at their smallest in the season of food scarcity from November to April. At this time herds smaller than 10 including all male herds are usual, and solitary males occur in significant numbers. The herds fragment even further at the time of maximum food scarcity in January-February when herds smaller than 5 animals are very common. These small herds often comprise of females with one or two young. This picture changes radically when the growth of grass begins with the first showers in March or April. Animals then suddenly congregate into much larger herds. However, if the first showers are followed by a dry spell, the grass may dry up, and the food becomes scarce once more. This is immediately followed by a fragmentation of the herds. Only in late April or May do the conditions change more permanently with a lot of plant growth following persistent rain. This is also the beginning of the breeding season which lasts till August. Large herds become very frequent in the breeding season and herds of 40-50 are commonly encountered during the daytime. Males attach themselves to female herds and solitary males totally and bachelor herds almost vanish from the scene. The picture changes again as the rutting season draws to an end in September. At this time the solitary males reappear, and bachelor herds become quite frequent. At the same time the average size of a herd decreases.

These changes in the size and composition of herds appear to be governed by a balance between the conflicting demands of feeding efficiency and predator avoidance, with the balance being different for males and females. Efficiency in predator avoidance presumably increases with increasing herd size. Chital inhabit open country and rely for predator avoidance on a social warning system involving visual signals, warning calls and feet stamping, rather than on camouflage. Animals in a herd are obviously less wary than solitary animals, and seem to be less susceptible to predation. On the other hand feeding

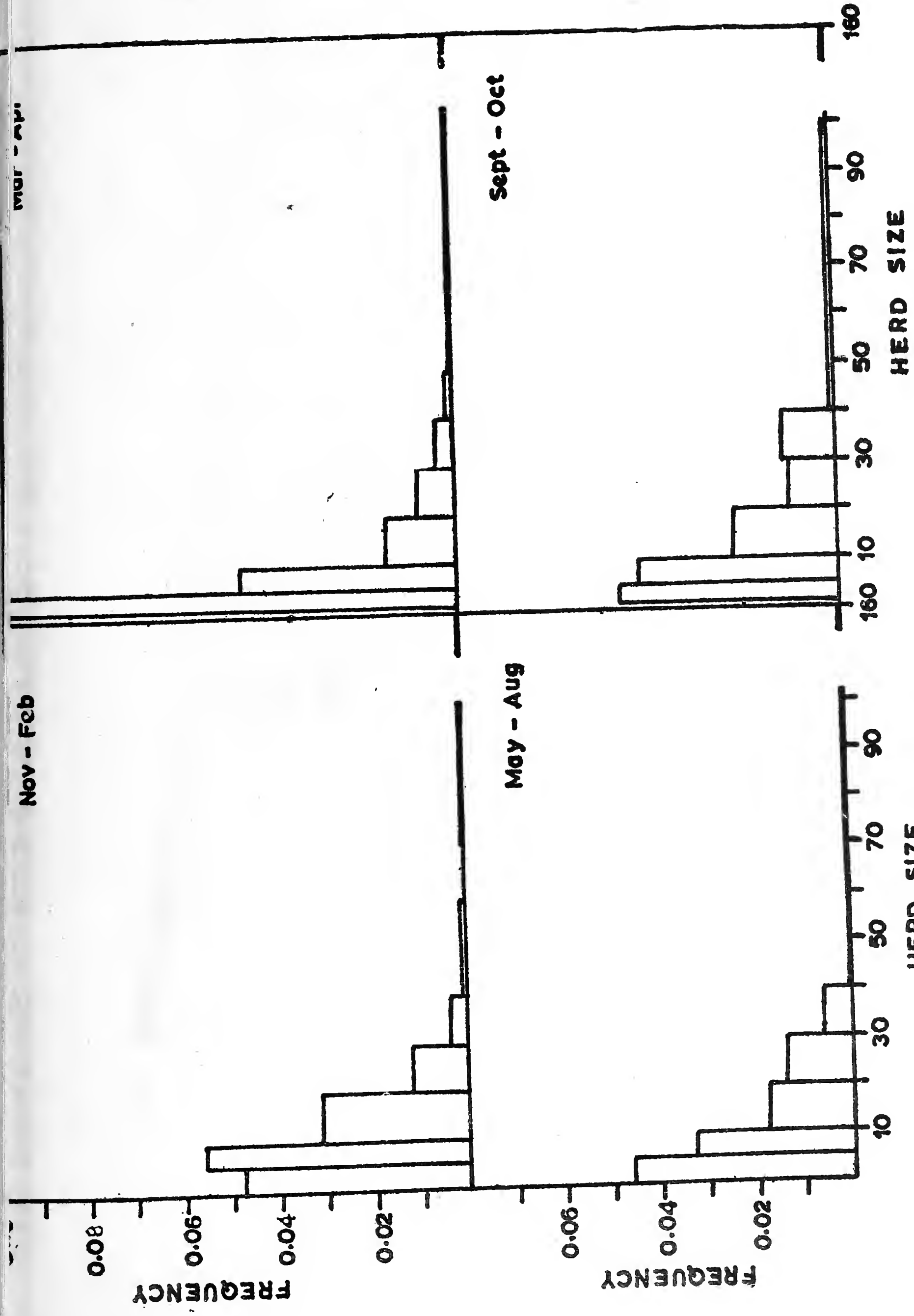


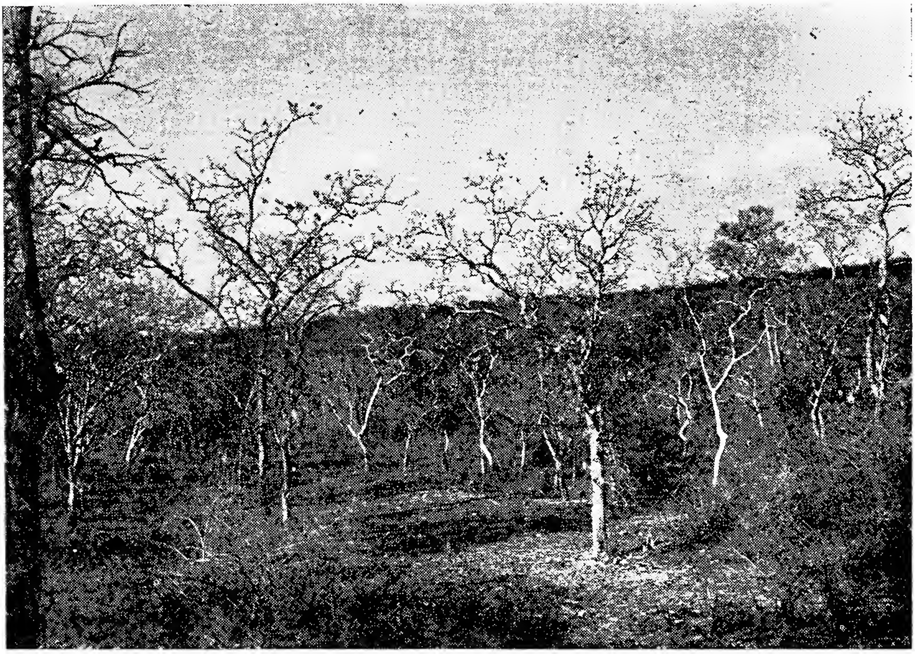
Fig. 9. The frequency distribution of herd size in chital at different times of the year.

efficiency appears to decrease with increasing herd size. There is always a fair amount of interference with each other during feeding of chital, and a large number of animals feeding in a small area must lower the feeding efficiency. If these assumptions are correct, then the demands of predator avoidance should favour large herds, while those of feeding efficiency should favour small ones. The actual herd sizes must result from a compromise between these conflicting demands. Whenever the demand for feeding efficiency becomes stronger, the compromise would be smaller herds, when it weakens the balance would shift towards larger herds. The demand for feeding efficiency may be expected to increase with declining food availability. We would then expect larger herds in seasons of food abundance fragmenting into smaller herds in seasons of food scarcity. This in fact is observed to be the case.

The two sexes differ from each other in the relative importance of feeding efficiency and predator avoidance. Chital is a polygynous species, and as with all other polygynous species there is a fierce male-male competition for females. A few males at the top of the hierarchy monopolise mating in such species and this also appears to be the case in chital. Since the position in the hierarchy crucially depends on physical growth, feeding efficiency is a very significant component of genetic fitness for the males. On the other hand, all females can and do reproduce and physical growth does not contribute so significantly to their reproductive success. The females grow to a smaller size and do not have the burden of developing a fresh set of large antlers every year. Feeding efficiency must then be much less important for the females.

Predator avoidance on the other hand seems to be more important for the females. They are much more alert than the males, and more apt to investigate the slightest disturbance. This presumably results from the fact that females are accompanied by their young for much of the time. Our computations of the mortality rate showed that the young are highly susceptible to mortality, and this must to a large extent be due to heavier predation. Predator avoidance may therefore be expected to be far more crucial to the genetic fitness of the females.

We would then expect females to have a greater tendency to participate in larger herds than males. This is in fact the case. Solitary males and small all male herds are much commoner than solitary females—almost never seen—or small female herds. The males seem to attach themselves to females chiefly for the purposes of breeding and solitary males or small all male herds are rare only during the breeding season. Females are almost always accompanied by fawns and this very much restricts their movements and that must impair the feeding efficiency to some extent. This is probably the reason for the tendency of the males to leave the females to form all male herds during the non-breeding season.



Above: In the month of May 1974, towards the Base of Bolagudda from an Elephant back. *Below*: In the month of October 1974, inside the forest (about 9 km from the lodge).

(*Photos*: *Sharatchandra*)

Above: Chital; very close to lodge (July 1974). *Below*: Elephants; near Yerekatte a pond which does not dry up in summer (September 1974).

(*Photos*: *Sharatchandra*)

Chital herds seem to be fairly fluid in composition. We have however twice observed behaviour which suggests that particular animals do tend to stay together. In both these instances a small number of animals behaved as if they had strayed from their herd and appeared to be searching for their missing herd. In both cases the male in the group gave a call similar to the alarm call, but with a longer note. No other deer responded to them. Although the deer saw several other deer, they did not merely join the first herd encountered, but appeared to have waited till they located their own herd.

Other behaviour patterns:

The basic behaviour patterns of chital have been described by Graf & Nichols (1966), Schaller (1967) and Eisenberg & Lockhart (1972), and our observations confirm their results. The Bandipur population however seems to exhibit a much higher incidence of homosexual mountings both amongst males and females, and of agonistic interactions during feeding, particularly amongst females. This may result from the very high concentration of animals, particularly in the most intensively observed Bolagudda sub-population.

Elephant

Population size:

The Indian elephant (*Elephas maximus*) is the dominant mammal of Bandipur although it is abundant only seasonally between April and November. As figure 10 shows, the number of elephants in the study area in the dry season from December to March remains around 40, but increases to 300 in the wet season. The maximum density is thus 13.4 elephants or a biomass of 24254 kg per sq km, while the average density is 3.9 elephants or a biomass of 7059 kg per sq km. This is more than 30 times the biomass of 217.2 kg per sq km recorded for the Wilpattu National Park in Sri Lanka. Our estimate of density is probably too high because the elephants do wander extensively out of the study area of 23 sq km.

While at Bandipur the elephants are concentrated around waterholes like Tavarekatte, Ministergutti, Aralikatte and Kolakmallikatte. Their distribution appears to be governed by the supply of bamboo, tall grass and water. In the dry season the elephants migrate into the wetter forests of Mudumalai and Wynaad.

Age, sex and herd composition:

Out of the total sightings of 854 elephants, 142 were adult males,

59 young males, 436 adult females, 74 young females and 143 calves. This gives a ratio of 2.5 females to 1 male, and a ratio of 0.6 immatures and calves to 1 adult female.

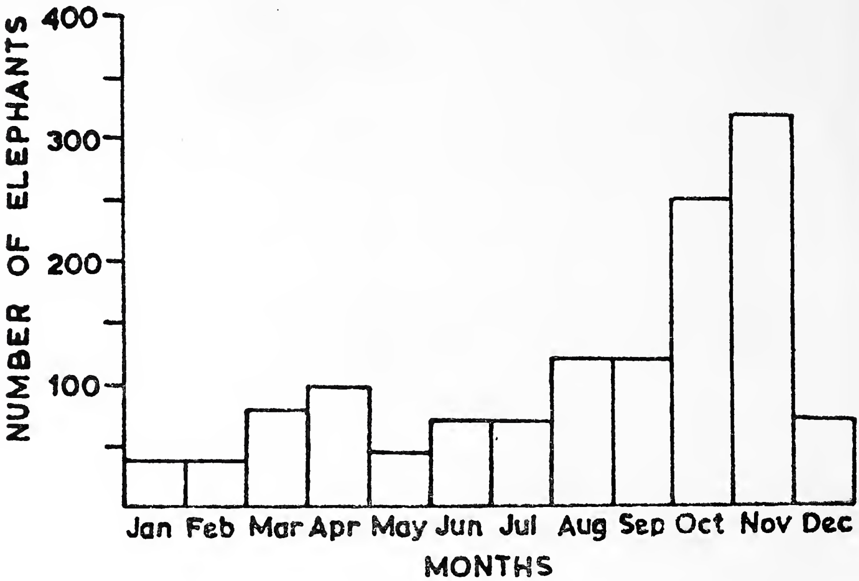


Fig. 10. The total population of elephants in the study area in the various months of the year.

Elephant herds are composed of matriarchal units of one or more adult females, and several immature males and females. These are undoubtedly family units. A herd may include several such units along with loosely attached males. When spread out in grazing the animals within a family unit tend to remain close together, while different units may separate from each other. Elephants generally occur in herds of 10 or less, though herds as large as 80 may be seen. Many such herds often come together at water-holes forming aggregations of as many as 150 animals. Males often occur solitarily, but females never do so (see figs. 11 & 12). As with chital, elephants form larger herds in seasons of food abundance, which fragment into smaller herds in seasons of food scarcity, and the interpretation of these changes appears to be similar to that for chital.

The elephant herds differ from herds of chital in being more cohesive, and in exhibiting co-operative behaviour to a much greater degree. This difference is probably attributable to three factors: (i) The elephants can and do actively defend the babies, while chital rely on hiding them. This provides for much greater scope for co-operation amongst elephants. (ii) An elephant baby may have several siblings born to its mother while it is still dependent on the mother for protection, while chital mature by the time the next sibling is born. (iii) Ex-

perience, for example, of migration routes plays an important role in the life of elephants, while such experience is probably unimportant for a sedentary species like chital. A mature female elephant can then have several immature babies dependent on her to various extents accompanying her. At the same time, she herself may benefit from continued association with more experienced females such as her elder sisters or mother. There is tremendous scope for the evolution of co-operative behaviour in such a group of closely related individuals. In elephants such co-operation seems to have developed particularly for protection of young against predation and nursing of infants.

Female elephants are extremely alert to any source of danger, and

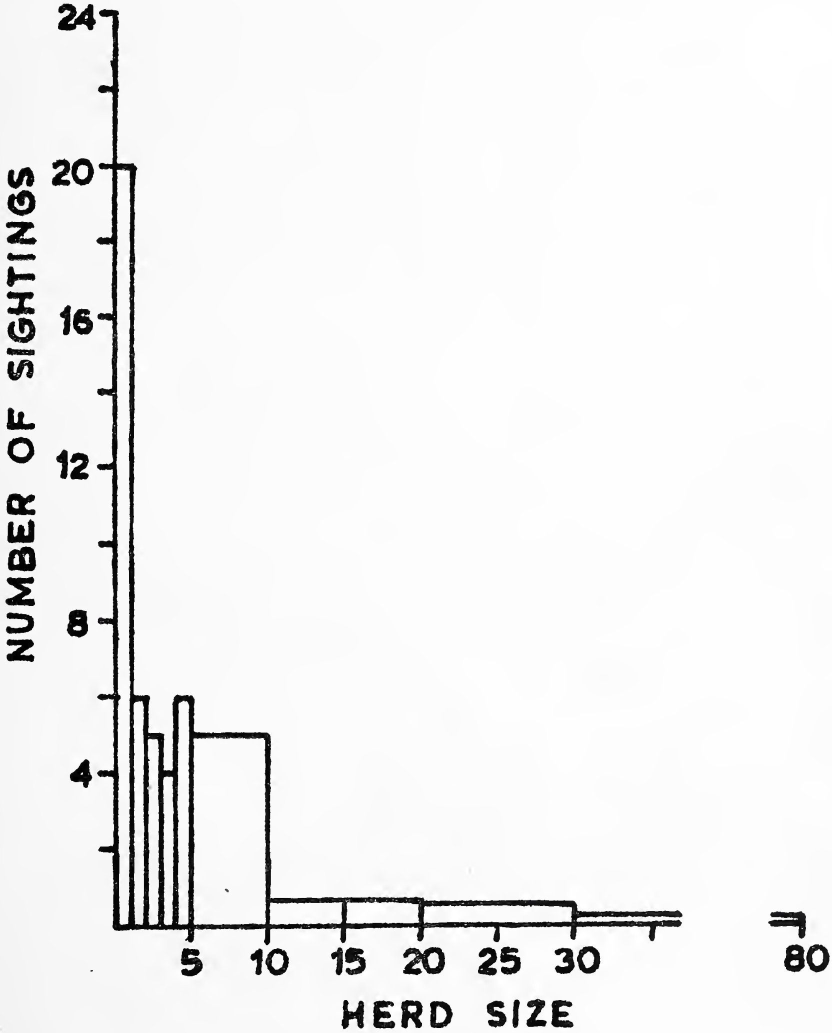


Fig. 11. The frequency distribution of herd size in elephants.

on the slightest disturbance come together, place the babies in between themselves and face the source of danger. This behaviour has been well described by Eisenberg & Lockhart (1972) and needs no elaboration here. The phenomenon of co-operative nursing however seems to be less well documented. Female elephants appear to continue mammary secretion throughout their life after the birth of the first baby. Observations on tame elephants at Bandipur as well as at Mudumalai suggest

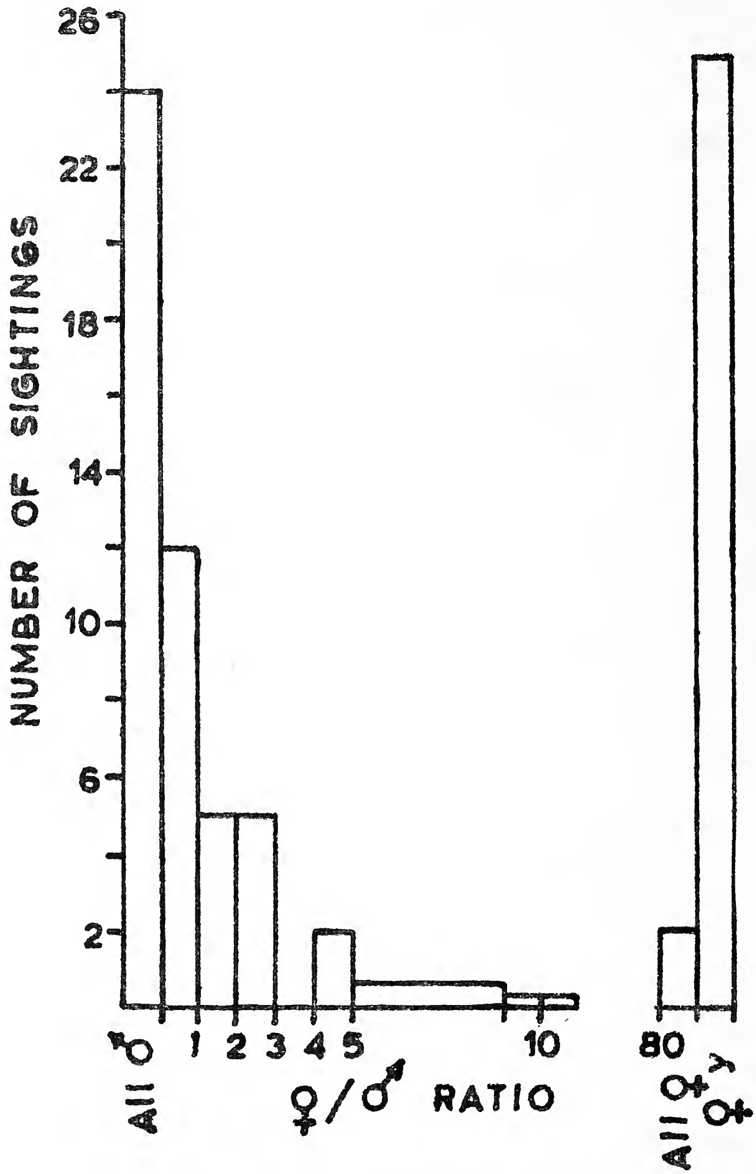


Fig. 12. The composition of the elephant herds. Symbols as in fig. 8.

that mature females without a nursing baby allow other babies to suckle. More remarkably, a mature tame female, Radhika, without a baby of her own showed a swelling of her udders a week before another tame pregnant female Ganga, gave birth to a baby at Bandipur. The swelling of her udders was evidently a response to an impending birth in her 'herd'. All these tame females are in fact wild caught, and are left out in the forest for grazing every day. Their behaviour presumably closely parallels the behaviour of the wild elephants. If this is so, co-operative nursing must be playing a vital role in the rearing up of elephant babies under natural conditions.

Wild dog

Population size:

Amongst the predators at Bandipur, droppings of the wild dog or dhole (*Cuon alpinus*) are noticed in the greatest profusion, and it is probably the major predator of chital and sambar. The actual number of sightings of wild dogs have ranged from 61 in October to none in June, September, November, December and April. Their distribution in the study area appears to coincide with that of chital and sambar. Although it is difficult to estimate their population, our guess based on visual observations of packs is 40 animals for the 23 sq km area, a density of 1.75 animals or 50 kg per sq km. This is a little over 2.5 per cent of the biomass of its major prey, chital.

Pack size and composition:

Wild dogs live in packs of 3 to 30 animals, the occasional sightings of one or two probably being stray animals (Table 2). A lame dog was noticed on three different occasions in the same area, once in a pack of 30, and twice in packs of 10 dogs. This suggests that the wild dog packs must have a certain fluidity, fragmenting and coming together at different times.

Table 2

The number of sightings of wild dog packs

Pack size	1	2	3	4	5	6	10	20	30
Number of sightings	3	5	8	4	–	2	3	1	1

Hunting behaviour:

Wild dogs prey mostly on chital as indicated by their droppings. Kills of chital of both sexes and all ages have been noticed. Kills of full

grown sambar also occur. Wild dogs killed a domestic water buffalo which had been provided as a bait for a tiger on the third night of being tied. Tribals who actually witnessed the killing report that a party of 15 adults and 15 pups feasted on the buffalo. Some droppings of wlid dogs also showed bird feathers, probably those of the blue-winged parakeet (*Psittacula columboides*).

Wild dogs hunt in packs of four or more, the kills being made in early mornings or late evenings. On sighting the chital, the dogs move towards them in a leisurely fashion in full view of the deer. Chital, in turn, bunch and start moving away at a slow pace. The final chase when the dogs sprint and the chital break into a run is a very brief affair probably lasting less than five minutes. A chital fawn was killed by being bitten neatly on its jugular vein, and a stag was first attacked with bites on the eye and anal region. The dogs consume their kill very rapidly and leave absolutely nothing but the skull, the radioulna and the tibiofibula. This was the case even with the water buffalo.

Communication:

We have so far noticed four different vocalisations of the wild dog. A dog once growled as it rushed at us on our approaching their pack on foot. The most commonly heard call is a low metallic whistle apparently used at the beginning of a hunt. The dogs were once heard to give a sharp yapping call when in full pursuit in thick cover and in failing light. A wailing contact call was noticed to be used by dogs scattered at the end of a chase. A dog actually seen giving this call stretched its forelegs fully, slightly crouched its hind quarters, and throwing its muzzle fully up wailed thrice in succession, very much in the classic manner of a wolf baying at the moon. This call was answered by an identical series of wails from a nearby thicket out of which a dog rushed and joined it.

Other Mammals

The other larger mammals of Bandipur include sambar (*Cervus unicolor*), barking deer (*Muntiacus muntjak*), four-horned antelope (*Tetracerus quadricornis*), wild pig (*Sus scrofa*), gaur (*Bos gaurus*), grey langur or the hanuman monkey (*Presbytis entellus*), bonnet macaque (*Macaca radiata*), sloth bear (*Melursus ursinus*), panther (*Panthera pardus*) and of course, the tiger (*Panthera tigris*). The smaller mammals of interest include black-naped hare (*Lepus nigricollis*), mouse deer (*Tragulus meminna*), giant squirrel (*Ratufa indica*), porcupine (*Hystrix indica*), and several species of smaller cats and mongooses.

Sambar occur in fair numbers, the study area harbouring about 20

individuals. They prefer thicker cover and take to hilly terrain more readily than do chital. The numbers in a herd range from 1 to 10. They show the interesting habit of making tunnels of about 1 to 2 m length, 1.5 m in height and 1 m in breadth in the lantana thickets in which they spend the hotter hours of the day.

Barking deer are seen either solitarily or in twos. The four-horned antelope are also solitary and rather rare. Wild pigs are fairly numerous and once a sounder of over 100 pigs was noticed fleeing a forest fire. There are six bisexual troops of 10 to 20 grey langurs in the study area. Chital regularly associate with them when the *Phyllanthus emblica* is in fruit to feed on the leaves and fruit dropped on the ground by the monkeys. There seems to be just one troop of bonnet macaques. Only occasional solitary bull gaur were seen in the study area till April 1975, mostly in the region bordering Mudumalai. A larger herd of 30 to 40 moved into Bandipur in late April 1975. Panther have been sighted five times, and the tiger only once over the entire year. The pugmarks of both are of course noticed much more frequently. Although it is difficult to hazard a guess, we believe that there are eight to ten tigers, and a somewhat larger number of panthers visiting the study area at least from time to time.

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Notes on the morphology and ecology of the Lesser Whistling Teal (*Dendrocygna javanica*)[1]

Eric G. Bolen[2] and M. Kent Rylander[3]

Problems associated with ecological isolation have long been central to evolutionary biology, as noted in the comprehensive review by Lack (1971). Moreover, among the waterfowl family Anatidae, the basic ecology of the eight species of whistling or tree ducks (*Dendrocygna* spp.) remains relatively unknown despite some studies of the New World species. Accordingly, we earlier developed a model and analysis that correlated morphological and ecological features for two species of whistling ducks sympatric in North America (Rylander & Bolen 1970). Among the features analyzed was the disproportionately larger foot size, as measured by middle toe length, for the otherwise smaller Fulvous Whistling Duck (*D. bicolor*) in comparison with the Black-bellied Whistling Duck (*D. autumnalis*).

Siegfried (1973) subsequently examined a second sympatric pair of whistling ducks in Africa, *D. bicolor* and the White-faced Whistling Duck (*D. viduata*), and found a similar divergence in foot size consistent with his observations of their respective ecological roles (i.e. divergence in the extent of their aquatic feeding habits). We later were able to demonstrate a comparable situation for two additional species sympatric in Australia (Bolen & Rylander 1974). Our model was also applied to the feeding apparatus and gaits of the Australian and North American species (Rylander & Bolen 1974a, b), including phenetic data suggesting parallel evolution between *D. autumnalis* in North America and the Plumed Whistling Duck (*D. eytoni*) in Australia.

As *D. bicolor* and the Lesser Whistling Teal (*D. javanica*) occur sympatrically throughout much of the Indian subcontinent, and thus represent still another example for study, we wish now to report on the foot morphology of the latter species, to compare these data with its Indian congener, and to offer suggestions concerning the ecological isolation that perhaps affected this pair of species.

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Methods

Twenty-seven *D. javanica* specimens housed at the Bombay Natural History Society were measured with vernier calipers for tarsal, middle toe, and exposed culmen lengths. Except for one specimen from Sri Lanka, all specimens were collected in India.

Unfortunately, published ecological data are scarce for *D. javanica*. Scattered references dealing qualitatively with food habits and nesting have necessarily been used in this report in lieu of quantitative information. Similarly, the habits of *D. bicolor* are not well known in India although approximations concerning this species' foods and nesting ecology may be reasonably drawn from studies elsewhere in its range.

Results

Mean linear dimensions for *D. javanica* appear in Table 1. These data well reflect the size of this species as the smallest among the eight species in the genus. Delacour (1954:44) provides the following additional size data (mm) for an unspecified number of birds:

wing: 170-204 tail: 53-55 culmen: 38-42 tarsus: 40-50

Table 1

Mean linear measurements (mm) for 27 Lesser Whistling Teal (*D. javanica*)[1]

Feature	Adults[2] (N = 16)	Immatures[3] (N = 11)	All birds (N = 27)
Culmen	41.5 (39.0-45.7) 1.9	39.7 (37.1-42.6) 1.4	40.7 (37.1-45.7) 1.9
Tarsus	45.7 (42.7-48.6) 2.0	45.2 (41.3-48.2) 1.8	45.5 (41.3-49.8) 1.9
Middle toe	60.3 (55.5-63.8) 2.1	60.0 (56.5-64.1) 2.2	60.2 (55.5-64.1) 2.1

[1] Data shown are mean, range, and standard deviation.
[2] Includes 5 males, 6 females and 5 unsexed birds.
[3] Includes 6 males, 4 females and 1 unsexed bird.

The diminutive stature of *D. javanica* can be further appreciated when it is compared with Delacour's (1954:43) measurements (mm) of the Black-bellied or Cuban Whistling Duck (*D. arborea*), the largest of the genus:

wing: 230-270 tail: 100-105 culmen: 45-53 tarsus: 62-75

Whereas comparisons of linear data for sympatric pairs of whistling ducks in Australia, North America, and Africa uniformly show that one species in each pair has a disproportionately larger foot than the second and otherwise larger member of each pair, a similar comparison between the whistling ducks sympatric in India does not show this relationship (Table 2). *D. javanica* is about eight to nine-tenths the size

of *D. bicolor,* including foot size as measured by middle toe length. In other words, neither of these two species is morphologically better suited for aquatic life than the other, if we apply the criterion established for the other pairs of whistling ducks shown in Table 2. Thus, *D. javanica* and *D. bicolor* are not ecologically isolated by morphological differences related to securing food in different habitats (meadows, fields and shallow water vs. deep water), a strategy seemingly employed elsewhere among other sympatric pairs (Bolen & Rylander 1974; Siegfried 1973).

TABLE 2

PROPORTIONATE SIZES BETWEEN FOUR SYMPATRIC PAIRS OF WHISTLING DUCKS

Feature	Africa[1]	North America[2]	Australia[3]	India[4]
	D. bicolor/ *D. viduata*	*D. bicolor*/ *D. autumnalis*	*D. arcuata*/ *D. eytoni*	*D. javanica*/ *D. bicolor*
Wing	0.94	0.88	0.92	0.88 (0.87)[6]
Culmen	0.92	0.88	—[5]	0.87 (0.88)
Tarsus	0.97	0.89	0.88	0.82 (0.89)
Middle toe	1.15	1.03	1.18	0.90 (0.92)

[1] Analyzed by Siegfried (1973) based on measurements of 10 of each species except for middle toe where 7 *bicolor* and 8 *viduata* were examined.

[2] Analyzed by Rylander & Bolen (1970) based on measurements of 21 *autumnalis* examined by Bolen (1964) and 28 *bicolor* measured by Friedmann (1947).

[3] Analyzed by Bolen & Rylander (1974) based on measurements of 3 *arcuata* and 6 *eytoni,* plus wing data from birds examined by Frith (1967).

[4] Data from 27 *javanica* shown in Table 1. First column, below, uses *bicolor* measurements from Rylander and Bolen (1970); second column, in parenthesis, uses *bicolor* measurements from Siegfried (1973).

[5] The bill of *eytoni* is remarkably short, and singularly dissimilar from any of the other 7 species of *Dendrocygna;* this precluded use of culmen measurements as a useful indicator of size relationships in this instance.

[6] Wing size was determined from the unweighed average (187 mm) of the extreme measurements (170-204 mm) listed by Ali & Ripley (1968:139) for *javanica.*

We therefore suggest a second strategy leading to ecological isolation, namely that *D. javanica* and *D. bicolor,* while in fact exploiting the same habitats with similar swimming and diving capabilities, secure vastly different foods. This strategy is rather common, accounting for fully 48 per cent of the isolation among European waterbirds as compared with 19 per cent frequency where isolation is maintained by no contact at all or 18 per cent where habitat selection provides the ecological barrier (Lack 1971:125, Table 18).

Intrageneric phylogeny

In each of the geographic comparisons shown in Table 2, with the exception of India, no species within any sympatric pair are known to be particularly close in their phylogeny. For example, *D. autumnalis* and *D. bicolor* were shown to be rather distantly related in a correlation phenogram employing 35 presumably non-adaptive features (Rylander & Bolen 1974a). However, in the present analysis, a close phylogenetic relationship may exist between *D. bicolor* and *D. javanica* (and also including *D. arcuata*). These three species perhaps form a superspecies complex as first suggested by Ripley (1945). The similarity in their body proportions, with particular regard to the ecological implications of their respective toe/tarsus ratios, is shown in Table 3. Accordingly, one might expect a priori that *D. javanica* and *D. bicolor,* if not diverging greatly in appearance and form, may have nonetheless done so in their food habits, thus fostering the second strategy of ecological isolation previously mentioned.

Table 3

Proportions among linear dimensions for 3 closely-related species of *Dendrocygna*

Ratio	*D. arcuata*[1]	*D. bicolor*[2]	*D. javanica*
Wing/tarsus	4.1	3.8 (4.1)	4.1[3]
Wing/toe	3.3	3.2 (3.3)	3.1
Toe/tarsus	1.3	1.2 (1.3)	1.3

[1] Analyzed by Bolen and Rylander (1974).

[2] First column, below, uses *bicolor* measurements from Rylander and Bolen (1970); second column, in parenthesis, used *bicolor* measurements from Siegfried (1973).

[3] Wing size was determined from the unweighed average (187 mm) of the extreme measurements (170-204 mm) listed by Ali & Ripley (1968:139) for *javanica.*

Comparative ecology

D. bicolor: This is one of the better-studied species of whistling ducks, perhaps because of its extensive distribution in North and South America, Africa, and portions of Asia. Rylander & Bolen (1970) noted the disproportionately large foot of this species and suggested that this feature was in keeping with its aquatic associations; the gait of *D. bicolor,* also quantitatively studied, is distinctively unlike the cursorial species of whistling duck (Rylander & Bolen 1974a).

Inconsistences appear in the literature regarding the nesting habits of *D. bicolor*. Perhaps these are due to ecological variation throughout its vast range (even though there are no acceptable geographical races). In any case, *D. bicolor* does not nest in trees or even perch on branches in Texas, California and Louisiana but instead nests in rice fields or dense clumps of marsh grasses (Dickey & Van Rossem 1923; Meanley & Meanley 1959; Cottam & Glazener 1959). Yet in India, Ali & Ripley (1968:140) described their nests as roughly built of sticks in hollow trees or in the forks of branches or, as with *D. javanica*, in abandoned nests of kites and crows.

The food of *D. bicolor* in India is not documented in the literature available to us. Elsewhere, their food consists of the seeds of grasses and sedges, and, in season, commercial rice (*Oryza sativa*). *Paspalum, Echinochloa,* and *Fimbristylis* each comprised 45 per cent or more of the spring and fall foods examined by Meanley & Meanley (1959) in Louisiana; no animal foods were reported. Moreover, our analysis of this species' bill structure indicated that food was secured by sieving action (Rylander & Bolen 1974b), presumably in the quest of seeds.

D. javanica: This small and interesting bird seemingly possesses traits found in one or more of the other species of *Dendrocygna* as well as some uniquely its own. Ali (1969:40) and Ali & Ripley (1968:138) note that the species perches freely in trees yet walks and dives well. Henry (1955:411) similarly observes that it walks well on land, with a slight waddle, but that the birds' "true home is in the water where it swims powerfully and dives readily—both in play and for food—descending to at least 6-8 feet and remaining submerged for many seconds on occasion."

There are regrettably only general accounts of this species' nesting habitat and these, again, indicate a remarkable amplitude. For example, Whistler (1949:523) reports nests on the ground or slightly elevated in masses of dense herbage whereas the "ordinary nest is in a tree, either in the deserted nests of crows and kites, or in hollows in the trunks and branches or between the boughs." Ali & Ripley (1968:139) also note the foregoing and add that nests among reeds and scrub bordering a jheel are fairly substantial pads of leaves, rushes, and grass.

The foods of *D. javanica*, like the sites of its nests, again sets this species apart from what is known of other dendrocygnid food habits. However, there has been no systematic study of a series of stomach or crop contents from any portion of *D. javanica's* range. Dharmakumarsinhji (n.d., p. 100) reports that plant materials as well as fish and insects are secured by upending or diving. Worms, snails, fish, and even frogs and other animal matter are listed by Ali (1969:40) in addition to shoots and grain. In Ceylon, Henry (1955:411) cites that whereas a vegetable diet seems preferred, large quantities of molluscs are devoured. *D. java-*

nica may graze "like a goose" yet it also eats rice and small fish, frogs, and worms and snails (Ali & Ripley 1968:139). Baker (1908:103) noted that large quantities of a brittle-shelled freshwater snail are ingested, an observation he undoubtedly made from birds taken during the hunting season. Most authors remark, rather emphatically, that the flesh of *D. javanica* is rank and unpalatable, seemingly from the flavour induced by the heavy utilization of animal matter in the diet.

In summary, *D. bicolor* and *D. javanica* appear to have somewhat similar nesting habits, at least in India where nests in trees or in marshlands are employed. The nests of *D. bicolor* are "very like that of lesser whistling teal" (Ali & Ripley 1968:140). However, in the New World, as in Africa (Roberts 1958:52), *D. bicolor* seldom, if ever, perches or nests in trees and instead nests in marshlands. Both are good divers and swimmers. An important difference may be in the utilization of animal foods by *D. javanica* whereas *D. bicolor* feeds exclusively on the seeds of aquatic grasses and weeds.

Conclusion

Our examination of foot structure, as measured by middle toe length, for the two closely-related species of whistling ducks occurring sympatrically throughout much of India indicates that *D. bicolor* and *D. javanica* exhibit no obvious morphological advantages, one over the other, for aquatic locomotion (cf. Bolen & Rylander 1974). Accordingly, we suggest that these species remain ecologically isolated because of differences in food habits with one (*D. javanica*) selecting large quantities of animal matter and the other (*D. bicolor*) utilizing seeds of marsh plants. However, we stress the need for a quantitative account of stomach and/or crop contents of both species in India so that the matter may be resolved with more clarity. Thereafter a detailed anatomical examination of the feeding apparatus of *D. javanica* might further explain the means by which ecological isolation is maintained (cf. Goodman & Fisher 1962; Rylander & Bolen 1974b). Moreover, the intriguing nesting habits of both species, particularly the utilization of abandoned platform nests of herons and other species requires orderly investigation.

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Studies on Palms: fruits, seeds and their germination in *Livistona chinensis* R. Br.[1]

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(*With a plate and* 26 *text-figures*)

Introduction

Many palm fruits and seeds are found in the Tertiary deposits of different countries. Fruits are called *Palmocarpon* and the seeds *Palmospermum*. Some palms like *Sabal* are represented by fragmentary leaves as well as by seeds. In London Clay Flora, Reid & Chandler (1933) found remnants of *Livistona*, called by them as *Livistona minima*. The fossil seeds are smaller than that of any live species of *Livistona* today.

By close and careful observation of the form and size of seed itself, form and position of hilum, raphe and chalaza, position of the embryo, presence or absence of rumination, nature and structure of the testa, and especially by studying the combination of these characters, it is possible to distinguish between seeds of many genera to a considerable degree of certainty. To identify fossil fruits and seeds of palms study of the living genera is absolutely essential (Mahabalé 1950). With this aim in view anatomy of different palm fruits such as *Nypa, Hyphaene, Sabal, Caryota, Cocos, Licuala, Rhapis, Phoenix, Ptychosperma* etc. has been investigated by us.

Anatomy of palm fruits in general is very meagrely known. Juliano (1926) described the development of stony layer in the fruits of *Cocos nucifera*. Lang (1943) has described the developmental anatomy in *P. dactylifera*. Recently Mahabalé (1965) described anatomy of fruits in *Cocos nucifera, Phoenix sylvestris, Licuala grandis, Caryota urens*, etc. He has also described a small palm fruit called *Palmocarpon in-*

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signe resembling small-seeded *Cocos, C. plumosa* and *C. coronata* (Mahabalé 1950, 1965). Biradar & Mahabalé (1969) have described the anatomy of fruit in six species of *Phoenix* as seen in T.S. passing through the middle part of mature fruit and seed.

Description

Morphology.—The fruits in the genus *Livistona* are drupes with thin bluish-green epicarp, fleshy mesocarp and stony endocarp. In *L. chinensis* the fruit is about 2 × 3 cm. In *L. jenkinsiana* it is more or less spherical and measures about 2.5 cm in diameter. Of the three carpels only one grows to maturity and forms a single seeded fruit. The calyx is persistent (Text Figs. 1-2, 9, Pl. Figs. 1, 2, 4, 5). The abortive carpels are seen at times as two small black projections on persistent calyx on one side of the fruit.

A T.S. passing through the middle part of the fruit shows—(i) Epicarp consisting of (a) epidermis and (b) hypodermis, (ii) mesocarp, (iii) stony endocarp, (iv) seed coat and (v) endosperm (Text Fig. 5).

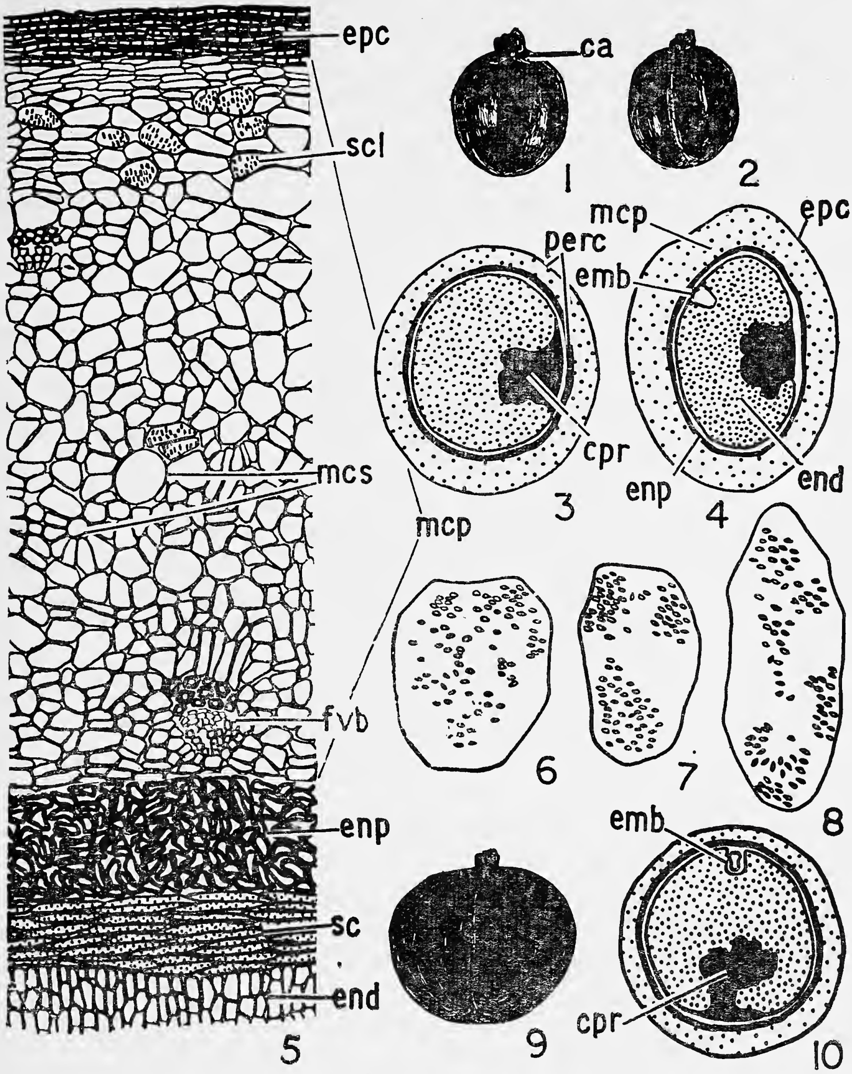
Epicarp.—The epidermis consists of rectangular to cubical cells with a thin layer of cuticle on them. The hypodermis is made up of 2-5 layers of compactly arranged oval cells containing chloroplasts (Text Figs. 4, 5, Pl. Fig. 7).

Mesocarp.—The mesocarp can be roughly divided into two zones. The outer zone consisting of loosely arranged cells containing fibrovascular bundles and mucilage sacs here and there. The mucilage sacs are irregular in shape and are usually surrounded by radiating cells of parenchyma (Text Fig. 5). Isolated as well as groups of pitted sclerenchyma cells are scattered in this zone (Text Figs. 5-8, Pl. Figs. 7, 9, 10, 11). The inner zones consist of layers of somewhat compactly arranged cells abutting on the endocarp. They are oval or tangentially elongated. Mucilage sacs are rare. Large fibrovascular bundles, ensheathed by well developed fibrous cap, are found in the inner zone of the mesocarp. They have a large patch of pholem xylem composed of angular vessels and protoxylem (Text Fig. 5, Pl. Figs. 7, 8).

Endocarp.—The endocarp is stony and is composed of 6-8 layers of stone cells having highly sclerotic walls. The inner layers of endocarp which are adjacent to seed coat are somewhat compactly arranged.

Seed coat.—The seed coat is formed by both the integuments and in T.S. shows 5-8 layers of homogenous thick-walled elongated cells (Text Fig. 5).

Endosperm.—Endosperm completely fills the seed cavity at maturity. Its cells are compactly arranged and are radially elongated. They contain numerous oil globules (Pl. Fig. 12).



Text Figs. 1-10. *Livistona* R. Br. Anatomy of fruit in *L. chinensis* and *L. jenkinsiana*.

Fig. 1. *L. chinensis*. Entire fruit showing the persistent calyx—*ca* × 1.2. Fig. 2. *L. chinensis*. Entire fruit showing a furrow on the ventral side × 1.2. Fig. 3. *L. chinensis*. T.S. of fruit showing the pericarp—*perc*, seed with endosperm—*end*, and chalazal portuberance—*cpr* × 2. Fig. 4. *L. chinensis* L.S. of fruit. Epicarp—*epc*, mesocarp—*mcp*, endocarp—*enp*, endosperm—*end*, and embryo—*emb* × 2. Fig. 5. *L. chinensis*. T.S. of fruit showing epicarp—*epc*, mesocarp—*mcp*, endocarp—*enp*, seed coat—*sc*, and endosperm—*end*: Note the pitted sclerenchyma cells—*scl*, fibrovascular bundles—*fvb*, and mucilage sacs—*mcs* in the mesocarp. Figs. 6-8. *L. chinensis*. Pitted sclerenchyma cells from the mesocarp × 200. Fig. 9. *L. jenkinsiana*. Fruit with a furrow on the ventral side × 1.2. Fig. 10. *L. jenkinsiana*. T.S. of fruit showing the embryo—*emb* and chalazal protuberance—*cpr* × 2.

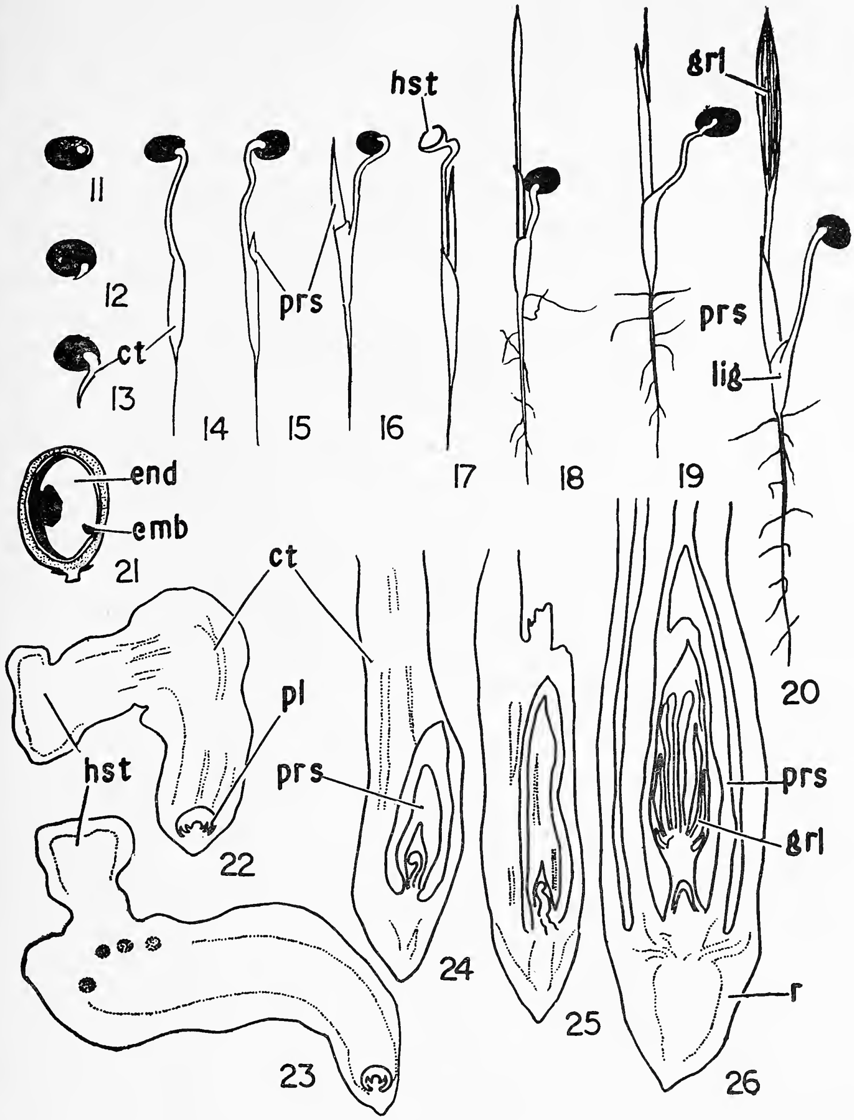
Ruminations.—Chalazal ruminations of protuberances in the seed are very prominent in both the species, *Livistona chinensis* and *L. jenkinsiana*. They occupy almost 1/3 the seed cavity and are supplied by vascular traces (Text Figs. 3, 4, 10, Pl. Figs. 3, 6). Sometimes these protuberances proliferate quite vigorously and reach even the embryo. Such chalazal protuberances are seen in other species of *Livistona* also, and in many members of the *Sabaleae* like *Sabal, Licuala,* etc.

Germination of seed and seedling morphology.—Seeds in the genus *Livistona* are oblong, hard and stony (Text Figs. 11, 12, Pl. Figs. 13-21). They germinate quite readily. The seeds sown with fleshy mesocarp germinate very slowly. The mesocarp probably creates some substance which retard their germination and growth. The fresh seeds of *Livistona chinensis* were sown about 5 cm below the surface of well manured soil. A few seeds were taken out each time to study different stages in germination at stipulated intervals.

The embryo of *Livistona* has two seed or cotyledonary leaves one of which is rather very small and rudimentary. As the seed germinates its minute embryo grows and forms cotyledonary leaves which do not expand into green assimilatory leaves, but remain partly or wholly underground. The germination is hypogeal. In it the much modified parts of the cotyledon corresponding to the blade, petiole and cylindrical sheath of a normal leaf can often be recognised (Text Figs. 22, 24, Pl. Figs. 26, 27).

Apex of the larger cotyledon corresponding to the leaf blade remains embedded in the endosperm or the food reserve of the seed. It functions as a suctional organ or an haustorium. The surface layers of the haustorium secrete enzymes which convert the endosperm into soluble substances which pass through the cotyledon and nourish the seedling till it is capable of independent growth (Text Figs. 13, 21-23, Pl. Figs. 13-15, 24-26).

The suctorial organ goes on enlarging till it occupies the entire space within the seed, formerly filled by endosperm. When dissected out of seed, it resembles a small peltate leaf (Text Fig. 17). The cotyledonary sheath elongates 6-10 cm in length. As a result the under-developed plantlet plumule is carried well below the soil surface (Text Figs. 13, 14, Pl. Figs. 14-17, 21, 22, 23, 26). Eventually the first young leaves of the seedling grow out through a long narrow oblique depression. The first root, the radicle, appears before the plumule. The rudiments of this first root are present in the embryo ensheathed by cotyledonary tissues (Text Figs. 24, 25, Pl. Figs. 26, 27). As it grows, it bursts through the base of the cotyledonary sheath and appears as a prolongation of the cotyledonary organ. The radicle persists for a limited period and is replaced by adventitious roots. As in all monocotyledons, it is incapable of growth originating from the base of the developing stem. The first



Text Figs. 11-26. *Livistona chinensis* R. Br. Germination of seed and its morphology.

Figs. 11-13. Early stages in germination. Cotyledonary tube—*ct* coming out of the seed × 3/4. Fig. 14. Bulged cotyledonary tube indicating increase in the size of the plumule × 3/4. Figs. 15-16. Production of the pointed protective sheath—*prs* × 3/4. Fig. 17. Haustorial organ—*hst* dissected out at the same stage × 3/4. Figs. 18-20. Further stages in germination till the first green leaf is produced—*grl* × 3/4. Fig. 20 × N.S.: Note the ligule—*lig* and the protective sheath—*prs*. Fig. 21. L.S. of fruit showing the position of the embryo—*emb*, and the endosperm—*end* × 1½. Figs. 22-23. L.S. of the germinating embryo × 10; Plumule—*pl* coming out of the cotyledonary tube—*ct*, while a part of the em-

bryo remaining inside serving as an haustorium—*hst*. Figs. 24-25. L.S. of cotyledonary tube—*ct* showing the formation of protective sheath—*prs* × 15. Fig. 26. L.S. of the cotyledonary tube showing the formation of the first green leaf—*grl* inside the protective sheath—*prs*, and the radicle—*r* × 15.

plumular leaf consists of a protective sheath only and is without a green blade. Its apex is rigid and pointed and very effective in penetrating through the soil to the surface (Text Figs. 15-17, Pl. Figs. 18, 19). Subsequent leaves are also first enveloped by this sheath, but eventually their green blade expands and comes above the soil surface (Text Figs. 18-20, Pl. Fig. 20). A tubular structure known as ligule is produced by the proliferation of cells around the mouth of the cotyledonary sheath. According to Gatin's classification (1906) the germination of this palm is of the '*Remotive ligulate*' type (Text Figs. 16, 20, Pl. Fig. 19).

Lamina of the first foliage leaf is simpler than that of adult leaf. There are several such simple juvenile leaves with increasing complexity until a typical foliage leaf is produced. As in most of the Sabaloid and Borassoid palms the first foliage leaf is simple and lanceolate and is succeded by leaves whose lamina is somewhat digitate. Later, as the leaves become larger and larger, they get deeply segmented and adult palmate leaf is produced (Text Figs. 24-26, Pl. Figs. 27, 28).

The seedling develops anchoring and absorptive root system together with an assimilatory leafy crown. Later it becomes independent of the seed. Its stem usually remains inconspicuous for a considerable time, 5-6 years. After the seedling stage, the stem grows first in girth and develops a broad woody subterranean stock before the leafy crown is raised up above the soil surface. The stem has no means of continuous growth in thickness as it has no cambium. As Holttum (1955) points out, the massive foundation is first established in order to support a woody trunk which is several feet high. This broad base begins to develop right from the seedling stage. The first few nodes at which seedling leaves are inserted have no distinct internodes. The successive nodes are increasingly wider and equally congested, so that the base of the stem assumes the shape of an inverted cone. Most of this early growth of stem takes place underground, and only the crown of leaves is visible above the soil surface for several years. Eventually, however, once a sufficiently broad base is developed, the later internodes elongate, the leafy crown is raised above the soil, and the tree trunk becomes woody.

Conclusion

All these morphological characters described here are also seen in the seeds of *Livistona minima* from the Tertiary Flora of London Clay; and hence notwithstanding the small size, their identification by Reid & Chandler (1933) as *Livistona* stands confirmed.

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The taxonomy of *Moschus* (Mammalia, Artiodactyla), with particular reference to the Indian Region[1]

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(*With a plate*)

Survey of literature and of available museum specimens shows that the three-species concept of *Moschus*, proposed by Flerov, is a valid one. Two of the species extend into the Indian region, *M. sifanicus* in the alpine zone and *M. chrysogaster* in the wooded lower slopes. The differences between the two are described and a taxonomic revision of the genus is proposed.

The lack of attention, in recent years, to questions of the taxonomy of larger mammals, especially ungulates, should not be taken as an indication that all problems in this field have been solved. As this paper intends to show, there are still many questions that are wide open, although plausible cases can be made out for a new look at old "certainties".

The Musk Deer of Asia has been accepted by most standard works, from Lydekker (1915) through Allen (1940) and Ellerman & Morrison-Scott (1951) to Heptner *et al.* (1961), as comprising a single species, *Moschus moschiferus* Linnaeus, 1758. However, as early as 1928 Flerov had doubted that such a scheme adequately expressed the complexity of the situation, and in spite of some cold water thrown on this view by Allen (1940), he renewed his three-species view at a later time (Flerov 1952). Lately, renewed collecting in China led Kao (1963) to support Flerov's scheme, again with modifications.

Flerov's first classification (1928) divided *Moschus* into three species:

M. moschiferus Linnaeus, 1758. Siberia, Korea, Manchuria. 5 subspecies recognised.

M. chrysogaster Hodgson, 1839. Northern India, Nepal, Kansu and

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Szechwan. 2 subspecies recognised.

M. berezovskii Flerov, 1928. Szechwan. Monotypic.

In this scheme, the first species is allopatric to the other two, which either overlap or approach each other's range in Szechwan—*M. berezovskii* being confined to alpine pastures, *M. chrysogaster* occurring throughout the forest zone of the west-Chinese mountain slopes, as well as in the Indian region. His scheme was presented in greater detail in a later paper (Flerov 1930).

In his later revision (Flerov 1952) he somewhat changed his opinion, reducing the number of subspecies and rearranging the nomenclature. Whereas earlier he had given the type locality of *Moschus moschiferus* as "Russian Altai" (from Linnaeus's "Tataria versus Chinam"), he now stated baldly that the species had been described from a northern Indian specimen. The name *moschiferus* thereby took precedence over *chrysogaster,* while the Siberian musk-deer must take the next available name (*sibiricus*). The three species were:

M. sibiricus Pallas, 1779. Only two subspecies.

M. berezovskii Flerov, 1928.

M. moschiferus Linnaeus, 1758. Two subspecies.

In the blitz on subspecies, *M. m. arcticus* described by himself (1928) had been synonymised with *sibiricus* as had *parvipes* Hollister, 1911 and *turowi* Zalkin, 1945, with the only valid subspecies (the nominate race apart)in that species being *sachalinensis* Flerov, 1928 from Sakhalin island; within the species previously called *M. chrysogaster* but now *M. moschiferus,* Flerov continued to uphold *sifanicus* Büchner, 1891 as a valid race.

Kao's approach (1963) differed from Flerov's in its more limited scope. It would seem that Flerov had mostly specimens from Soviet territory, with a few from China; Kao's were all from China, and there was no attempt to link them to forms described from outside Chinese borders, except that the Manchurian musk-deer was referred to *M. moschiferus,* rejecting Flerov's revised interpretation. The three species recognised were:

M. moschiferus sibiricus Pallas, 1779: Manchuria.

M. berezovskii Flerov, 1928: wooded zones from Szechwan to Kwangsi.

M. sifanicus Büchner, 1891: alpine zone of western China.

The most remarkable change is here that the ecological relations of *berezovskii* and *sifanicus* are reversed from the conception of Flerov. Flerov had stated, on Büchner's authority, that the dwarf *berezovskii* lived in the alpine zones, with *sifanicus* in the montane woodlands of the slopes. It is clear from Kao's statements that Büchner had been in error. Kao writes (translation kindly arranged by Dr Robert Hoffmann, University of Kansas Museum of Natural History):

Habitat of *sifanicus* is the high plains of Tibet and Ching-hai, for the most part 2000 to 3000 or even 4000 metres above sea level.... In the west of Szechwan in the perpendicular interlocking areas with the forest musk deer, they are certainly the most abundant musk deer type. A cross section of the said perpendicular interlocking areas extends north to the grassy plains and marshland of the pine forests of Te-lu, Szechwan, and southward to the high mountain areas of Te-chin, Yunnan, at 3500 metres above sea level.

He says that *sifanicus* is called Ma-chang (horse-roebuck), and is unanimously affirmed by hunters to live in high mountains; the small, dark *berezovskii,* Lin-chang (Forest-roebuck) live in low mountains.

The specimens obtained by Kao and his colleagues proved to be this way: big light-coloured animals in the alpine meadows, small nearly black ones in the forest. (It can be recalled that Engelmann (1938) had also given this distribution, on the field evidence of Schäfer, but without naming the two contrasting forms).

Thus the two species, *sifanicus* and *berezovskii,* overlap—apparently without interbreeding—from Mu-li (28.12 N, 100.50 E) and Li-t'ang (30.02 N, 100.18 E) in the south to Ma-erh-k'ang (not found) and P'ing-wu (32.30 N, 104.30 E) in the north. Beyond these areas, only one species or the other occurs: *sifanicus* at Te-lu (25.40 N, 103.42 E) and Te-chin (28.28 N, 98.48 E), *berezovskii* at Yen-yüan (27.30 N, 101.40 E). The latter species seems to extend westward into low-lying woodland areas: Kao records it from Kwangsi province at Ching-hsi (23.10 N, 106.28 E), Kweichow province at Kuei-yang (26.35 N, 106.40 E) and Shensi province at Mei hsien (= county), 34.12 N, 107.50 E. In the British Museum (Natural History) are two specimens referable to *berezovskii* from Ichang (30.43 N, 111.22 E), also a lowland locality.

The three species occurring in China may be described as follows (using Kao's nomenclature for the moment):

1. *M. moschiferus* (extending south probably to the Hwang-ho): a large species; dark brown, usually spotted; two white stripes on lower part of neck, extending to shoulder. Ear-backs dark. Individual hairs are grey-white for two-thirds of their length, then brown-grey, with a darker brown tip; commonly there are whitish rings near the tips, which, when clumped, give the overall spotted effect. The fur is soft compared to the other two species, 45-60 mm long on the withers, 65-75 mm on the rump (in the Siberian race; but in Korean skins these lengths amount to only 34-37 mm and 45-62 mm respectively). In the skull, the halfway point falls within the orbit or at its anterior border; the dacrimal is at least as broad as long; the supraorbital arches do not extend above the dorsal outline of the skull.

2. *M. berezovskii.* A small species, but not smaller than the Korean race of *moschiferus*; very dark, olive-brown with nearly black haunches and buttocks; no spots; underside of throat and breast light to white.

Ear-backs dark, blackish. Individual hairs are grey at the base (over about a third of their length), with the shaft dark brown, and a reddish yellow ring near the tip. The fur is harsh, 38-50 mm on the withers and 48-70 mm on the rump. The skull is very like that of *moschiferus* but has a relatively shorter braincase.

3. *M. sifanicus.* Large; light in colour, sandy yellow or light brown (Kao); no spots except for a few vague ones on dorsum; yellow or white below. Ear-backs with broad yellow zone at tip. Individual hairs lead grey at base, light brown on most of shaft, an orange or yellow ring, then a dark brown tip. Fur harsh, 31-46 mm on withers and 45-68 mm on rump. Skull differs from that of the other two in its long face, with the skull midpoint falling forward of the anterior orbital margin; lacrimal longer than broad; supraorbital arches well-marked, rising above dorsal outline of skull.

These descriptions are taken from Flerov, as modified by Kao. As far as the British Museum materials extend, however, they confirm the literature findings. Specimens of *M. moschiferus* are fairly plentiful; in addition to the B. M. material there is a series of adults and young in the Zoological Museum, Berlin, from Lake Telezker (= Teletskoye), in the Altai, while Egorov (1965) gives detailed descriptions of musk-deer from Yakutia, with comparisons of series from Tokko River (57.30 to 60.00 N, 120.00 E) and the Verkhoyansk range, which differ weakly. Kao's paper includes descriptions and measurements of specimens from Heilungkiang and Kirin provinces. From all these data it is possible to see a broad division of the species into two subspecies, apparently distinct enough though not recognised by Flerov (1952):

1a. *M. m. moschiferus.* Occupying the northern and western parts of the range, the Altai and Sayan ranges, Yakutia north to the type locality of Flerov's rejected race *arcticus* (Mt. Toulaiakh-kaia, Northeastern Taskhaiakhtakh range, about 68.00 N, 139.00 E). To judge by the measurements provided by Kao, specimens from I-ch'un, northern Heilungkiang (47.41 N, 129.10 E), would be referable to this subspecies though tending towards the next race in their short lacrimals and presumably—since no colour differences are mentioned from other Manchurian examples—in their dark colour. In this race the colour is dark brown to light grey-brown, the hair-bases whitish; the size is large (skull length as in Table 1, metacarpal and metatarsal lengths respectively 128-148 and 172-189 mm. (Flerov 1952)); the lacrimal is long, often slightly longer than broad; the nasal bones form a wedge into the frontals behind.

1b. *M. m. parvipes.* From the Soviet Far East (Amur-Ussuri district) and Korea, extending into Kirin province and southern Heilungkiang (localities, in Kao's paper, Shang-chin (45.13 N, 127.59 E) and Lake Ching-po-hu (about 44 N, 129 E)). This is decidedly smaller;

for skull measurements see Table 1; metacarpals 125-128, metatarsals 166-170 (Flerov 1952); lacrimal short; nasals abbreviated behind, not wedge-shaped. The colour averages darker with the hair-bases grey; but some specimens of similar colour can be found amongst the lighter individuals of the nominate race (such as the type of *arcticus* Flerov). It is a puzzle why Flerov (1952) no longer recognises this present race, though it is retained by Heptner *et al.* (1961).

A third subspecies, not seen by me, is recognised by Flerov (1952) and Heptner *et al.* (1961):

1c. *M. m. sachalinensis.* The description of this race recalls *parvipes* very closely except in one respect: that the interorbital breadth is less than the postorbital breadth, the opposite to the condition in both other forms. Otherwise it seems virtually indistinguishable. It is confined to Sakhalin island.

Musk-deer of the Tibetan plateau

The two species *berezovskii* and *sifanicus,* which overlap without interbreeding (according to Kao) in Szechwan, are poorly represented in collections in the West. The British Museum has the following specimens:

3.5.15.6. "Szechwan". Medium to dark greyish; ears dark, nearly black, throughout. No skull. Clearly represents *berezovskii.*

1.3.2.6. Ichang (young). Pepper and salt grey, very coarse-haired; the dark bands on the hairs nearly black; ears dark grey becoming black at tip. Skull has *berezovskii* characters.

1.3.2.3. Ichang (adult). Skull only; typical *berezovskii.*

11.9.8.144. Wen Chuan, Szechwan (31.29 N, 103.40 E). Young: Third molars not yet broken through. Dark greyish, with blackish bands on the hairs; ears dark. Skull typically *berezovskii.*

11.2.1.265. Tau-Chou, Kansu (perhaps T'ao Chou, now Lin t'an, 34.39 N, 103.40 E); young, similar to last in age. Light grey brown; ears with broad yellow tips. Skull broken, but lacrimal certainly much longer than broad. This is obviously *sifanicus;* altitude "8,500 feet".

18.10.8.1. Shigatse. Slightly darker than the last but still noticeably lighter than the first few skins. Ear yellow near tip. Skull typically *sifanicus.*

Apart from these six, there is a skin from "S.E. Tibet" which is an albino, and nothing more can be said about it; and a skull with no skin from "N.E. Peling Mts", probably a young *berezovskii;* this may be Mt. Pai Ling in Kwangsi at 23.20 N, 105.50 E. It will be seen from Table 1 however that two Kwangsi skulls of this species—according to the data of Kao and of Wang *et al.*, 1962—are extremely small, and may

prove to represent a new subspecies: but if this surmise is correct, then the "Peling" skull cannot belong here as it is 145 mm long, though immature.

It is clear in any case that the two Tibetan-plateau species can be distinguished on the basis of museum material as well. For the figures in Table 1, specimens of *sifanicus* from Ta-tsien-lu in the Paris Museum have been included, and specimens of *berezovskii* from Wen-chuan-hsien in the American Museum of Natural History (kindly communicated by Dr G. G. Musser).

Musk-deer of the Indian region

It has been shown above that the concept of two species of Musk-deer of overlapping distribution, differing in ecological requirements, is a valid one for the montane region of western China. The problem is now to allocate the musk-deer of the Indian region: India, Nepal, Sikkim and Burma (Bhutan being unrepresented in collections). Flerov assumed throughout that it is *sifanicus* which is represented in the Indian region, but as we have seen his concept of that species was in error; moreover he is unlikely to have had more than one or two specimens to work with (for example, he in no case gives skull measurements).

The specimens in the British Museum (Natural History) amount to the following: Skins with skulls, 2; skins alone, 5; skulls alone, 11. In addition there is 1 skin with skull, and 5 skins alone, in the collection of the Bombay Natural History Society. (This list excludes specimens without locality). Two skins without skulls from Burma—one in London, one in Bombay—will be treated separately.

A brief description of each specimen follows:

a. London, BM (NH): Skins and skulls.

43.1.12.93. "Nepal"; type of *chrysogaster* Hodgson, 1839. Medium to dark yellow-brown, apparently slightly faded from the "bright sepia" of Hodgson (1839). Ears dark throughout. Skull length 152 mm; lacrimal somewhat longer than broad; supraorbital arches not elevated; midpoint of skull within orbit. Except for the lacrimals, and perhaps the rather larger skull, all of these features correspond with *berezovskii*.

15.9.1.238. Lachung, Sikkim, 8,800′. Head-skin only; ears brown with clear light, yellow rims. Skull length 164 mm; lacrimal much longer than broad; supraorbital arches somewhat elevated above dorsal outline; midpoint in front of orbit. All these features resemble *sifanicus*, but the restriction of the yellow zone to the rims of the ears is different.

b. BM (NH): Skins only.

43.1.12.95. "Nepal"; type of *leucogaster* Hodgson, 1839. Less yellow than *chry-*

sogaster but otherwise very like it, with dark ears. In the catalogue of Lydekker (1915) this specimen is stated to have a skull, but it does not today.
91.10.7.175. Sikkim. Very dark brown; ears entirely dark.
91.10.7.174. Sikkim. Nearly black. Ears dark.
8.2.29.4. Rishi Nala (perhaps in region of Rishikesh?), Garhwal, 12,000′. Grey brown; ears with light rims like the Lachung specimen.
39.833. Chamba. Brown-grey, limbs somewhat greyer; vague traces of spotting on back. Ears with light rims.

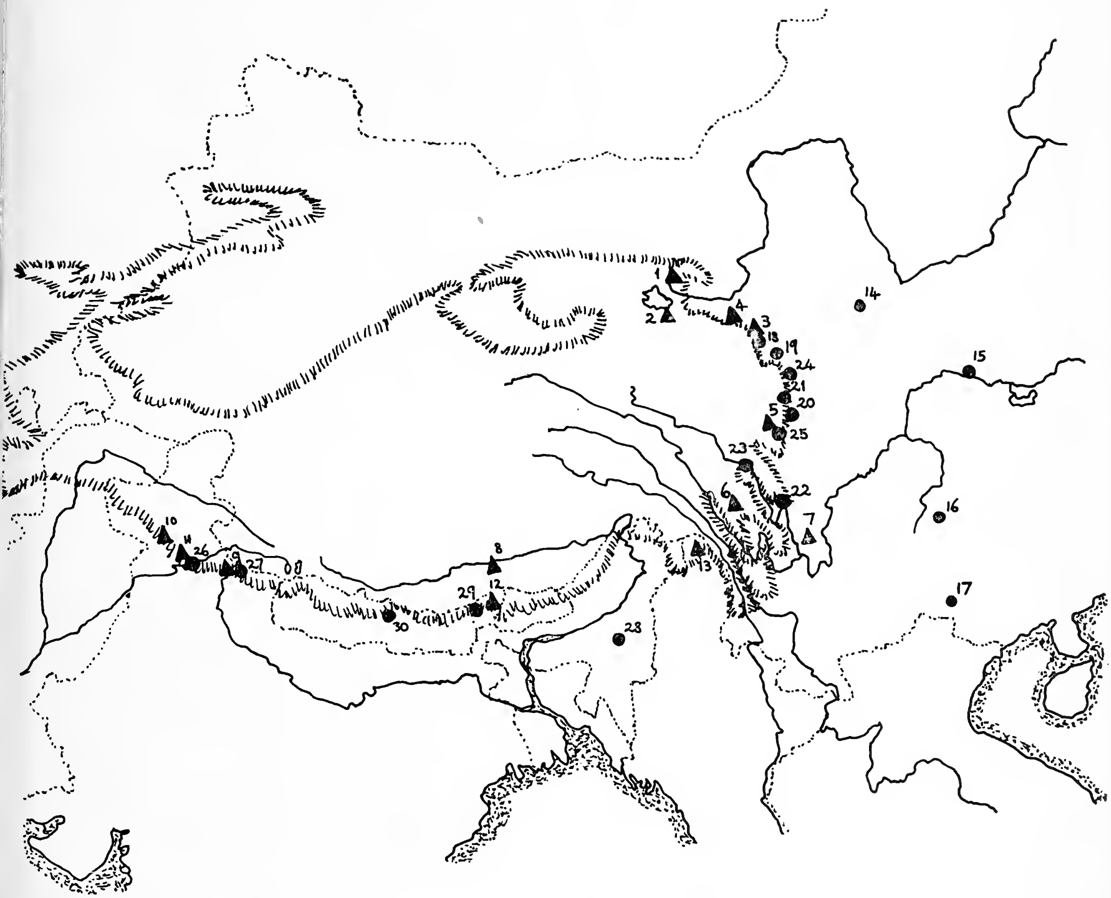
c. BM (NH): Skulls only.

91.8.7.221. Kashmir. Length 150 mm; lacrimal somewhat longer than broad; midpoint in orbit; arches not much elevated.
91.8.7.222. Kashmir. Incomplete; lacrimal longer than broad; arches somewhat elevated.
30.1.2.57. Length 155 mm; lacrimal longer than broad; midpoint in orbit; arches not elevated.
43.1.12.98. "Nepal"; type of *saturatus* Hodgson, 1839. Length 159 mm; lacrimal longer than broad; midpoint in orbit; arches not elevated. Hodgson describes the skin as "Dusk brown"; by the time Lydekker compiled his catalogue of British Museum mammals (1915) the skin was no longer in the museum.
678a. "Nepal". Length 151 mm; lacrimal longer than broad; midpoint in orbit; supraorbital arches not at all elevated.
48.6.11.26. Length 149 mm; lacrimal slightly longer than broad; midpoint in orbit; arches somewhat elevated.
6168c. Lachen, Sikkim, 8,000′. Length 148 mm; lacrimal longer than broad; midpoint in orbit; arches not elevated.
43.1.12.97. Cachar; type of *cacharensis* Lydekker, 1915, nom. nud. (ex Hodgson ms.). Length 150 mm; lacrimal somewhat longer than broad; midpoint in orbit; arches slightly elevated.
47.325. Sikkim, 11,000′. Length 155 mm; lacrimal much longer than broad; midpoint well in front of orbit; arches elevated.
43.1.12.94. "Nepal". Length 163 mm; lacrimal much longer than broad; midpoint in front of orbit; arches elevated.
26.10.8.71. Jaunsar, U.P., 8,000′. (Locality not traced). Length 161 mm; lacrimal much longer than broad; midpoint well in front of orbit; arches strongly elevated.

d. Bombay Natural History Society.

17843. Konal Nullah, Kulu, 9,500′. Very dark colour; ears wholly dark. Skull length 158 mm; lacrimal somewhat longer than broad; midpoint on or in front of anterior rim of orbit; arches slightly elevated. The skin is clearly *berezovskii* but the skull would not be typical.
17844. Nepal. Dark brown; ears dark.
17842. Gorkha, Nepal. Dark chocolate-brown; ears dark.
17847. Garhwal. Rather dark brown. (Head missing).
(Display mounted skin). Kula valley, 9,000′. (This might be the Kula valley in Bhutan, near Monla Karchung, or more likely a lapsus for Kulu, 31.58 N, 77.06 E). Diffuse light pepper-and-salt greyish; ears light-rimmed.
17846. "Sikkim, Tibet". Light pepper-and-salt; light-tipped ears.

Two additional skulls should be mentioned, both from the Berlin collection, both subadult. 13483 from "Assam", nearly adult, has a length of 137 mm; lacrimal longer than broad; midpoint in skull; arches not elevated. No. A. 29.00



Map of the distribution of *Moschus sifanicus* and *Moschus chrysogaster*.

(For locality details, see overleaf)

Localities are as follows:-

M. sifanicus (triangles).

Chinghai:

1	Men-yuan	37.28 N,	101.50 E
	Kukunorih	35.00 N,	101.00 E
2	Kung-ho	36.20 N,	100.46 E

Kansu:

3	Archuen	34.00 N,	102.00 E
4	T'ao Chou	34.39 N,	103.40 E

Szechwan:

	Te-lu	?25.40 N,	103.42 E
5	K'ang ting = Ta-tsien-lu,	30.05 N,	102.04 E

Yunnan:

6	Te-chin	28.28 N,	98.48 E
7	Tien-chih	25.00 N,	102.40 E

Tibet:

8	Shigatse	29.18 N,	88.50 E

India:

9	Rishi Nala = ?Rishikesh,	30.07 N,	78.19 E
10	Chamba	32.33 N,	76.10 E
11	Kula valley = ?Kulu,	31.58 N,	77.06 E
	Jaunsar, U.P.	?	?

Sikkim:

12	Lachung	27.42 N,	88.48 E

Burma:

13	Adung-seingku confluence and Dchpu L'kha; both	28.10 N,	97.30 E

M. chrysogaster (circles).

Shensi:

	Shung-wang-heng		?
	Shun te-p'eng		?
	T'ai-pai-shan		?
14	Mei hsien	34.12 N,	107.50 E

Hupeh:

15	I-chang	30.43 N,	111.22 E

Kweichow:

16	Kuei-yang	26.35 N,	106.40 E

Kwangsi:

17	Ching-hsi	23.10 N,	106.28 E
	Pai-ling	?23.20 N,	105.50 E

Kansu:

18	Archuen	34.00 N,	102.00 E
19	Sikou	33.50 N,	104.23 E

Szechwan:

20	Wen-chuan	31.29 N,	103.40 E
	Cheng Wei		?
21	Ma-erh-k'ang	31.34 N,	102.25 E
22	Yen-yüan	27.30 N,	101.40 E
	Jang-t'ang		?
23	Li-t'ang	30.02 N,	100.18 E
24	P'ing-wu	32.30 N,	104.30 E
25	Ta-tsien-lu.	30.10 N,	102.10 E

India:

26	Konal Nullah, Kulu	?	?
27	Garhwal	30.20 N,	78.30 E
28	Cachar (Hills?)	25.30 N,	93.00 E

Sikkim:

29	Lachen	27.40 N,	88.36 E

Nepal:

30	Gorkha	28.01 N,	84.37 E

from "Calcutta", slightly younger (but with all teeth erupted) is 154 mm long, with midpoint in front of orbit and arches elevated (lacrimals are missing).

This list is an interesting one; unsatisfactory in that there are so few associated skins and skulls, but showing quite clearly the existence of two colour types: a dark type with dark ears, indistinguishable from the Chinese *berezovskii,* and a light type with yellow-rimmed ears, recalling *sifanicus* but not identical to it (ears only rimmed with yellow, not broadly tipped; colour perhaps greyer, less yellow).

The skulls cannot be so decisively placed in two groups. Without a doubt they are heterogeneous lot; for example, the length of fully adult skulls varies from 148 to 164 mm, a variation which cannot be ascribed to geographic variability as both largest and smallest skulls are from Sikkim! The lacrimal bone is almost always longer than broad, though the degree of excess varies. The position of the skull midpoint is probably the easiest character to use in a division of available skulls into two groups, as it divides the smaller ones (148-159 mm) from the larger ones (155-164 mm), with a weak correlation with degree of elevation of the supraorbital ridges and the degree of lacrimal elongation. In fact, all these features would tend to be correlated anyway: a larger skull would mean a longer face, so doubtless a longer lacrimal, and maybe a flatter interorbital surface giving added prominence to the supraorbital arches. That this correlation is not fundamental, however, is shown by the Siberian species: the same size as *sifanicus,* it yet has a more *berezovskii*-like skull, though perhaps less distinctive.

One concludes from the survey of specimens from the Indian region that there are certainly two species represented, and that they correspond to the two in the southern Chinese mountains. They are, as in China, sharply distinct on the evidence of their skins, but, unlike in China, not so distinct in their skulls. The explanation for this is evidently that the "cf. *berezovskii*" race is larger in India than in China, so that its other skull features would, by allometry, approach those of the "cf. *sifanicus*" form. The very large skull of the type of *chrysogaster,* a *berezovskii*-like type, confirms this, and the strikingly large skull of Bombay no. 17843 extends this conclusion.

In the list, the skins are easy enough to assign to one species or the other; as follows:

1. *cf. berezovskii.*

43.1.12.93.	43.1.12.95.	91.10.7.175.	91.10.7.174.
Bombay 17843.	Bombay 17844.	Bombay 17842.	Bombay 17847.

2. *cf. sifanicus.*

15.9.1.238.	8.2.29.4.	39.833.	Bombay 17846.
Bombay, display skin.			

The skulls are plausibly divided as follows:

1. *cf. berezovskii.*

91.8.7.221.	91.8.7.222.	30.1.2.57.	43.1.12.98.
678a.	48.6.11.26.	6168c.	43.1.12.97.

2. *cf. sifanicus.*

47.325.	43.1.12.94.	26.10.8.71.

Of the two Berlin specimens, 13483 is certainly of the first type, A. 29.00 equally surely of the second. The basic division, for reasons explained above, has been made on the basis of position of skull midpoint, but the fact that in Bombay no. 17843, identifiable as type 1 on basis of the associated skin, the midpoint lies slightly forward of the orbital rim, dictates caution. One can however be reasonably certain of the correct allocation of the type 2 skulls: the smallest (47.325) on the basis of its 11,000-ft altitude (above the tree-line), the rest on the basis of their large size. Among the type 1 skulls, uncertainty must exist with the incomplete skull, 91.8.7.222 although its association in series with 91.8.7.221 renders its taxonomic association with it more likely; and the large skull, type of *saturatus,* must also be regarded as not certainly belonging here.

As would be expected from the ecological differences between the two, "*berezovskii*" has evidently been more easily obtained than "*sifanicus*"; the relative proportions are as follows:

Skins alone, 8 *berezovskii* to 5 *sifanicus*
Skulls alone 8 *berezovskii* to 3 *sifanicus*
Total 17 *berezovskii* to 8 *sifanicus,* approx. 2:1

Musk-deer of burma

U Tun Yin (1967) draws attention to the presence of the Musk-deer in Burma. He states that it is found in the snow-covered hills round Putao, and generally keeps above 8,000 feet.

There are two specimens in collections seen by me: both skins unaccompanied by skulls. B.M. 50.741, from the Adung-Seingku confluence at 5,000 feet, is a yellow-grey-brown; Bombay no. 17845 from Dchpu L'kha, Putao subdivision, is less greyish, a yellow-brown all over. These colours are quite different from any others seen by me; however Kao's description of *sifanicus* as "sandy yellow or light brown" suggests that they may not be entirely outside the range of this form. The hair patterns are different from those described for *sifanicus*: simply creamy-grey at the base, for four-fifths of the length, then yellow at the tip.

It seems probable that these skins represent *sifanicus;* on present evidence they seem to differ from this species in China, and are certainly very different indeed from Indian and Sikkimese examples; but the

paucity of material from China available outside the Academia Sinica collections, dictates caution in assessing the situation.

NOMENCLATURE

The first problem of nomenclature concerns the name *Moschus moschiferus* Linnaeus, 1758. The entry under this heading is as follows:

29. MOSCHUS. Cornua nulla.
Dentes Laniarii superiores solitarii exserti.
moschiferus. 1. Moschus. Syst. nat. 13.
Animal moschiferum. Ray. quadr. 127.
Capreolus moschi. Gesn. quadr. 695.
Capra moschus. Aldr. bisulc. 743. Jonst. quadr. 55, t. 39.
Moschus. Schröck. monogr. t. 44.
Habitat = Tataria versus Chinam.
Moschus substantia unctuosa ambrosiaca e folliculo prope umbilicum.
Schröcki Historia moschi. Wien 1682. quart.

Flerov (1928), going on just the "Tataria versus Chinam" part, nominated the Russian Altai as the type locality. Such a fixation would be acceptable could it be shown that no contrary evidence exists; even though Flerov himself later (1952) reduced its authority by giving a new "type locality" (northern India). It is necessary to go into Linnaeus's sources to see whether any localities or detailed descriptions are to be found there.

The first source, Ray (1693), gives quite a long description in Latin, which is taken directly from Grew (1681). The latter is a splendidly discursive description of the oddities and curios at that time in the possession of the Royal Society—among them, a stuffed Musk-deer. The description begins, "He breeds in *China*, and the *East Indies*..." and goes on to give quite a detailed description of the specimen. He at no time, however, says what colour it actually is; and, while saying that the ears are like a coney's, about three inches long, and erect (in a stuffed specimen, mind you!), he does not describe their colour either. (I suppose that, if this could be taken as negative evidence, it indicates that *sifanicus*, with its parti-coloured ears, is not in question).

Linnaeus's next three sources—Gesner, Aldrovandus and Johnstonus—are extremely unspecific and seem to confuse different animals under the same heading: the latter two even award the Musk-deer two horns! They are clearly unusable as far as taxonomy is concerned.

Schröckio (1682), Linnaeus's final reference, quoted also by Ray, is a very interesting book on musk—its source, extraction, uses and so

on. His data on the Musk-deer are all Chinese; he gives the generalised Mandarin name, *Xe* (usually transliterated *She* today) and its variant *Xehaing* (probably the same as Kao's *Chang*, used in Szechwan); and quotes, among others, Marco Polo, who supplies the only thing approaching a locality—"de regione Tebeth et Caniclu" (perhaps Kansu?). Fascinating though all this is, it really amounts to hearsay as far as the animal itself is concerned. Which throws us back onto the description of the stuffed musk-deer in the Royal Society.

The Royal Society's collection was presented to the British Museum in June, 1781; according to Thomas (1906) very few specimens in the BM (NH) collections can now be identified as coming from this source. The only specimen of *Moschus* whose source is not known is a skull, 676 k, said to be "from a skin in the old museum stores" according to the register. This is precisely where the Royal Society specimens would have ended up; but alas, the skull in question is female, whereas Grew clearly describes the sharp hooked tusks of the Royal Society specimen. I am indebted to Dr Alan Gentry of the Mammal Section, BM (NH), for discussions and correspondence on this matter.

The only part of Grew's description which could be diagnostic is the section describing the individual hairs: the hair on the back and buttock is

> 3 inches long... brown and white portions alternately from root to top.

The hair patterns of the three species of *Moschus* were described above. Only the Siberian musk-deer (the one provisionally called *M. moschiferus* above) has white rings on the hair: in both the other species the rings tend to be yellowish to some degree. If, therefore, Grew's description is accurate, then it seems to have been a Siberian musk-deer; also, 3 inches (77 mm) is a length approached more nearly by the Siberian species than by the other two. Accordingly Flerov is likely to have been right in 1928 and 1930, wrong in 1952, and his fixing of the type locality in 1928 as the Russian Altai may be accepted as being without demonstrable contradiction.

The earliest name for musk-deer from the Indian region is Hodgson's *Moschus chrysogaster* (1839). The localities of Hodgson's specimens have been discussed in a previous paper (Groves & Mazák 1967); the early date of Hodgson's specimen, together with those named *leucogaster* and *saturatus* at the same time, give no reason to doubt that they could really be from some part of Nepal. It has been shown above that all three type specimens are referable to the "cf. *berezovskii*" type of Indian musk-deer; as they antedate Flerov's name by nearly ninety years, they must take preference, the name *chrysogaster* being the first name for the "forest musk-deer"; this name was selected from the three by Flerov (1928) in his capacity as First Reviser, even though he used it incorrectly. It will be seen from Table 1 that, if skulls of this species

are correctly determined, then the Indian race is significantly larger and longer-faced than the Chinese, so that the name *berezovskii* remains valid at the subspecific level.

For the "horse musk-deer" (Kao), or, better, "Alpine musk-deer", it seems that the name *sifanicus* is the only one ever to have been applied. The Indian race differs in coloration from the Chinese, especially in the pattern on the ears; but until the differences can be specified with more accuracy, and the position of the Burmese form elucidated, it will be better not to designate the Indian race with a name beyond simply *Moschus sifanicus* subsp.

Taxonomic conclusions

A list of the taxa of the genus *Moschus* considered valid on the basis of the present study, follows below. Full references will be found in Ellerman and Morrison-Scott (1951).

1. Moschus moschiferus Linnaeus, 1758. Siberian musk-deer.

M. m. moschiferus Linnaeus, 1758. Siberia (see Heptner *et al.*, 1961); northern Heilungkiang province, China.

M. moschiferus Linnaeus, 1758. Russian Altai (Flerov, 1928).
M. sibiricus Pallas, 1779. Above Abakan (53.43 N, 91.25 E), Russian Altai.
M. altaicus Eschscholtz, 1830. Mongolian Altai.
M. m. maculatus, fasciatus and *concolor* Gray, 1872 (ex Milne-Edwards, 1864). Siberia.
M. m. arcticus Flerov, 1928. Mt. Toulaiakh-kaia, northeastern Taskhaiakh-takh range, 68.00 N, 139.00 E, Siberia.

M. m. parvipes Hollister, 1911. Korea, Primorskii Krai, Kirin, southern Heilungkiang.

M. parvipes Hollister, 1911. Mok-po (34.50 N, 126.25 E), S. Tscholla province, Korea.
M. m. turowi Zalkin, 1945. Terney Bay (45.40 N, 136.36 E), Sikhote Alin Reserve.

M. m. sachalinensis Flerov, 1928. Sakhalin island.

2. Moschus chrysogaster, Hodgson, 1839. Forest musk-deer.

M. c. chrysogaster Hodgson, 1839. Wooded slopes of Himalayas in India, Nepal and Sikkim (and Bhutan?).

M. chrysogaster, leucogaster and *saturatus* Hodgson, 1839. Nepal.
M. cacharensis Lydekker, 1915. (ex Hodgson ms.). nom. nud., Kachar.

M. c. berezovskii Flerov, 1928. Wooded slopes of southern China.

M. berezovskii Flerov, 1928. Ho-tsi-khow pass, Sikou, 33.50 N, 104.23 E, Szechwan.

M. chrysogaster subsp. uncertain; ?Kwangsi.

3. MOSCHUS SIFANICUS Büchner, 1891. Alpine musk-deer.

M. s. sifanicus Büchner, 1891. Alpine zone of Tibetan plateau region.
M. sifanicus Büchner, 1891. S. Kansu (Hsifan zone).

M. sifanicus subsp. (*M. chrysogaster chrysogaster* of Flerov, 1928; *M. mochiferus moschiferus* of Flerov, 1952). India, Nepal and Sikkim.

M. sifanicus subsp. Burma.

ACKNOWLEDGEMENTS

Grateful thanks are due to the staff of the Mammal Section BM (NH), of the Berlin Zoological Museum, Paris Natural History Museum, and the Bombay Natural History Society; to Dr. Robert Hoffmann for arranging a translation of Kao's paper; and to Dr Alan Gentry for useful discussions.

SKULL MEASUREMENTS OF *Moschus* spp.

	Greatest length			Lacrimal length			Lacrimal breadth			Source
	Mean	S.D.	n.	Mean	S.D.	n.	Mean	S.D.	n.	
MOSCHUS MOSCHIFERUS										
M. m. moschiferus										
Teletskoye Lake	150.8	3.21	14	20.4	1.55	14	19.4	1.03	14	1a
Tokko River	156.6	2.85	8	—			—			2
Verkhoyansk Ra.	153.2	2.12	3	—			—			2
I-ch'un	155.7	—	2	14.6	—	2	19.5	—	2	3
M. m. parvipes										
S. Manchuria	144.8	3.34	9	14.4	0.96	11	18.9	1.91	11	3
Korea	145.4	—	2	—			—			4
MOSCHUS CHRYSOGASTER										
M. c. berezovskii										
Szechwan	146.4	4.89	6	20.5	2.72	7	19.7	1.87	7	3,5
Szechwan	145.0	2.85	9	19.4	1.32	9	21.6	2.07	9	8
Shensi, Ichang	141.5	—	2	17.7	0.52	3	18.9	2.01	3	1b,3,6
M. c. subsp.										
Kwangsi	118.9	—	2	14.8	—	1	18.9	—	1	3,7
MOSCHUS SIFANICUS										
Cachar	150.0	—	1	22.0	—	1	19.0	—	1	1b
Sikkim, Nepal	150.0	1.83	4	24.8	0.50	4	18.5	0.58	4	1b
Kulu, Kashmir	154.3	4.04	3	25.5	1.00	4	20.3	0.96	4	1b,1c
MOSCHUS SIFANICUS										
M. s. sifanicus										
China	161.8	4.87	9	23.4	3.16	10	18.6	1.28	10	3,1d
Shigatse	163.0	—	1	25.0	—	1	23.0	—	1	1b
M. s. subsp.										
India, Nepal	160.4	3.58	5	26.2	0.84	5	19.6	1.52	5	1b

Sources:

1 — author's measurements:

a—Zoologisches Museum, Berlin

b—British Museum (Natural History), London

c—Bombay Natural History Society

d—Muséum National d'Histoire Naturelle, Paris

2 — Egorov, 1965

3 — Kao, 1963

4 — Flerov, 1928

5 — Musser, pers. comm. (ex American Museum of Natural History, New York)

6 — Allen, 1939

7 — Wang *et al.*, 1962

8 — Grubb, pers, comm. (ex U.S. National Museum, Washington).

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Heterostyly and breeding mechanism of *Nymphoides cristatum* (Roxb.) O. Kuntze[1]

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(*With two text-figures*)

Nymphoides Hill. (*Limnanthemum* Gmel.) of Menyanthaceae is a cosmopolitan hydrophyte, species of which show variation in floral morphology and mechanism of reproduction. Ornduff (1966) noted dimorphic heterostyly in many species, along with an incompatibility system. According to him, heterostyly has evolved into dioecism in this genus. I studied the South Indian species with regard to this aspect. The project was financed by the University Grants Commission.

Method and Material

The study was conducted in two steps, concentrating on *Nymphoides cristatum* (Roxb.) O. Kuntze. Extensive field survey was carried out to note range of distribution and composition of natural populations. Experimental investigation was the second step.

Morphology was studied on fresh material collected from different localities. For breeding experiments plants were grown in special tanks made insect-proof with thin wire net and glass. Steel needles sterilized with rectified spirit were used to transfer pollen in artificial pollination. Plants were kept in insect-proof tanks before and after pollination.

Description

Nymphoides cristatum (Roxb.) O. Kuntze. is a rhizomatous herb with floating petiole-like branches and alternate leaves. Lamina is deeply cordate, up to 10 cm in diameter. Flowers arise in cluster from a vagina at the junction of branch and petiole. Flowers are long-pedicellate, white with yellow centre, 1-1.5 cm in dia., characterised by a me-

[1] Accepted April 1973.

dian vertical flap of petal lobes. Stamens 5, free, epipetalous; anthers yellow, introrse. Androecium sterile in some. Gynoecium superior with unilocular ovary, conical style, bilobed stigma and 3-5 ovules on 2 parietal placentas. Seeds lenticular, finely echinulate.

Observations

N. cristatum is widely distributed in Kerala, thriving best in shallow open fresh-water, forming consociations or associations with other aquatics. In permanent waters, it is perennial. Flowering is seasonal in the field but plants in cultivation flower throughout the year. There is normal vegetative propagation through fragmentation.

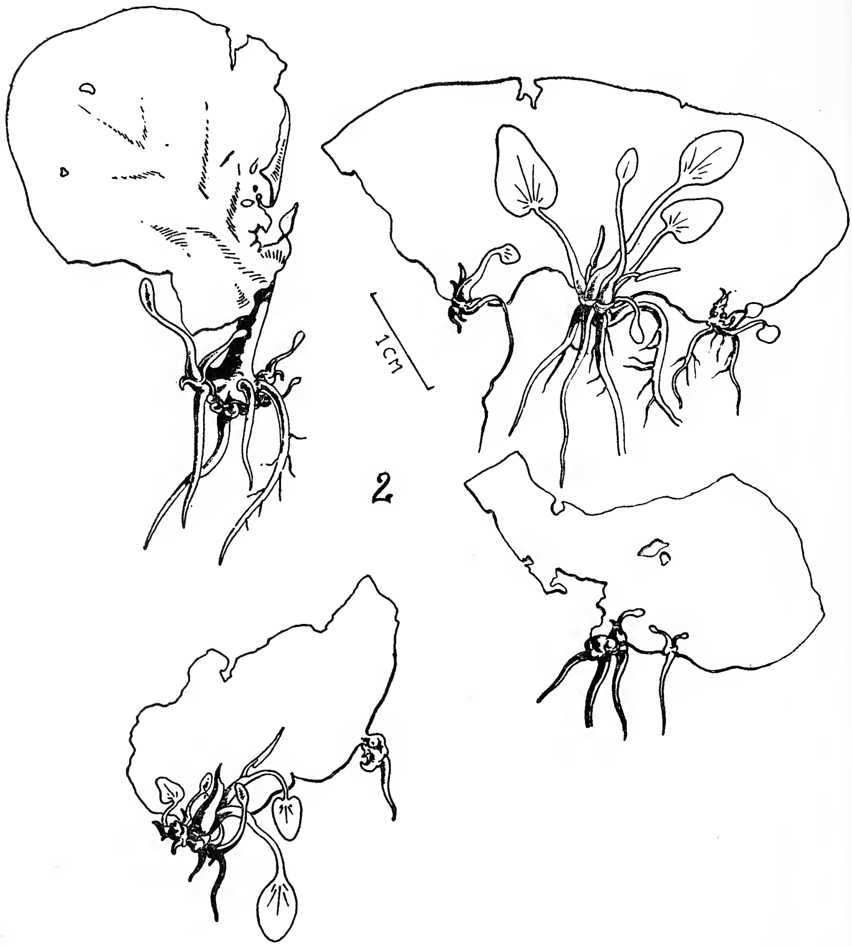

Fig. 2. Leaves with 'bulbils'.

Vegetative propagation through leaves, is common. As some tanks began to dry up in hot season, branches and leaves became progressively smaller. Some of the leaves were injured or broken. From the edges of the wounds, leafy buds with their own adventitious roots sprouted (Fig. 2). When transplanted, they grew up into normal plants.

There are no dormant buds concerned with the formation of these bulbils and they appear anywhere on the lamina and even on broken end of petiole. First step was formation of callus-like growth at the broken edge. Primordia of roots and then leaves appear soon. With the decay of lamina, the bulbils became free. This phenomenon is not found in healthy plants under favourable conditions. Apparently, increase in temperature and drought induce it. Plants facing destruction are trying to produce as many progeny as possible. If drought is not prolonged, the bulbils have a chance of survival.

Sexual reproduction:

N. cristatum is gyno-dioecious, having hermaphrodite and female plants. Flowers of these two forms (Fig. 1) are alike externally, but female has reduced, sterile stamens. Proportion of these two forms in natural populations is variable. Due to vegetative propagation, any one form may outnumber the other, but large well established populations always have both. Results of population counts made in different localities are given in Table 1.

TABLE 1

SEX RATIO IN POPULATIONS OF *N. cristatum*

Locality	Total No. of plants	Bisexual	Female
Tellicherry	48	30	18
Calicut	17	12	5
Badagara	31	18	13
Alwaye	43	21	22
Palghat	11	8	3
Chittur	13	5	8
Total	163	94	69

Monomorphic populations are rarely found in restricted spots like a small ditch. Growth of population being largely through vegetative means, they may be monomorphic during early stage, especially female ones.

Bisexual plants were grown in insect-proof tanks. They produced 512 flowers during the period of observation but only seven fruits were formed. The same tanks were kept open, allowing insect visit. Out of 200 flowers formed, 192 produced seed-bearing fruits. It is clear that

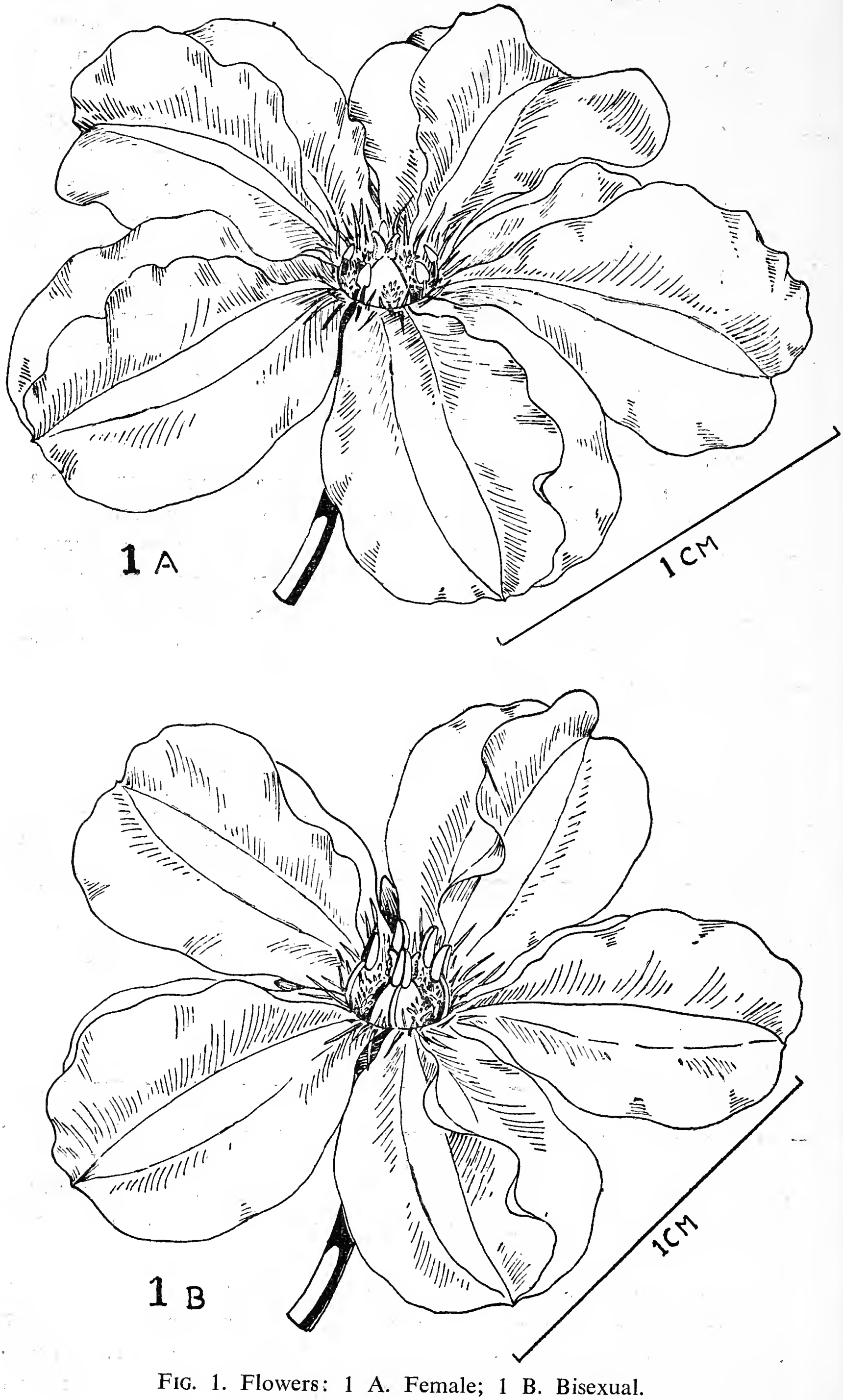

FIG. 1. Flowers: 1 A. Female; 1 B. Bisexual.

insects are necessary for pollination. Artificial pollination of bisexual flowers proved their self-compatibility. Female plants were grown first in insect-proof tanks and then in open tanks in isolation, with no bisexual plant in vicinity. In both cases hundreds of flowers were formed but not a single fruit. Then female flowers were pollinated with pollen from bisexual flowers. Out of 100 flowers, 91 produced fruits with 3-4 seeds, 4 produced 1-2 seeded fruits and 5 flowers withered. Evidently, female plants depend upon bisexual plants for pollen, got through insects.

Discussion

Floral structure shows that gyno-dioecism of *N. cristatum* is derived from heterostyly which is common in the genus. According to Hildebrand (1867) and Darwin (1877) dimorphic heterostyly is an adaptation to promote outbreeding and a step towards dioecism. It has since been found to be associated with an incompatibility system also. In some taxa, heterostyly has given way to inbreeding but a breakdown to increased outbreeding is found in Rubiaceae and Menyanthaceae (Ornduff 1966). This raises doubts about heterostyly being an adaptation for outbreeding. Where there is self incompatibility, heterostyly is unnecessary for outbreeding. Examining the pollen load on stigma of several heterostylous taxa, Ornduff (1966) found that heteromorphism does not promote 'legitimate' pollination. The conventional explanation of the mechanism of heterostyly is more a theoretical probability than a practical reality.

Heterostyly is a stage in the morphological modification leading to dioecism which ensures outbreeding. Self incompatibility can serve the same purpose but there is possibility of its breaking up and reversion to self fertility. So in many taxa like *Nymphoides,* incompatibility system is progressing into dioecism. Heterostyly, according to Crowe (1964) is only "degenerate form of homomorphic incompatibility from which it arises by loss of alleles". Similar view is held by Vuilleumier (1965). The two characters are governed by separate genes (Ernst 1936; Lewis 1954) and so there is possibility of any one being strengthened or weakened further. In *N. indicum* there is heterostyly as well as incompatibility and both forms are bisexual. In *N. cristatum* incompatibility system is broken up while heterostyly is advanced to gynodioecism. But the process is incomplete. Outbreeding is ensured only in the long-styled flower which has its stamens reduced. Similar reduction also of the gynoecium in short-styled flower results in dioecism, as in *N. macrospermum* Vasudevan. Thus the three species of *Nymphoides* show evolution of incompatibility system into dioecism for which heterostyly provides the morphological basis.

Summary and conclusion

Nymphoides cristatum (Roxb.) O. Kuntze. can grow as perennial and flower throughout the year if conditions are favourable. Besides normal vegetative propagation by breaking up of branches, it will produce 'bulbils' from leaves, under dry conditions. It shows gyno-dioecism derived from heterostyly, as a stage in the evolution of dioecism. Heterostyly is not an adaptation to ensure outbreeding but only a morphological modification to bring in dioecism.

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I am deeply indebted to Dr. Robert Ornduff of the University of California who encouraged me to take up this study and gladly provided me with recent literature on the subject. I am also obliged to Prof. K. Kesavan Nair, Govt. College, Chittur, who often brought me fresh specimens from different localities and helped me in preparing the photographs.

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Notes on some aspects of the biology of *Palaemon styliferus* Milne-Edwards from the Godavari estuarine system[1,2]

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(*With five text-figures*)

Palaemon styliferus an economically important prawn of the Gautami Godavari estuary on the east coast of India, occurs in the lower regions of the estuary almost throughout the year in considerable numbers but is most common in the month of November. The food habit of the prawn is almost similar to its counterpart from the Hooghly estuary. The growth rate, however, is slightly faster in the Gautami estuary. The breeding season is restricted to a short period, generally extending from October to December.

INTRODUCTION

Only a few of the palaemonid prawns of Indian estuaries are of commercial value. *Palaemon styliferus* Milne-Edwards, is one among them and is widely distributed in the estuarine and brackish waters of India (Kemp 1917; Annandale 1922; Ganapati & Subrahmanyam 1964) and contributes to the commercial fishery in the Hooghly estuary on the east coast (Kunju 1955) and the inshore fishery at Bombay on the west coast (Rai 1933). It is also reported to be of some economic value in the backwaters of Travancore-Cochin (Menon 1954).

Apart from a detailed account of the biology of *Palaemon styliferus* given by Kunju (op. cit.) from the Hooghly estuary no subsequent observations seem to have been made on the biology of the species from other estuarine systems. The species has been recorded in the Gautami estuary, the largest of the Godavari estuarine system (Ganapati & Subrahmanyam, op. cit), but it does not form a large scale

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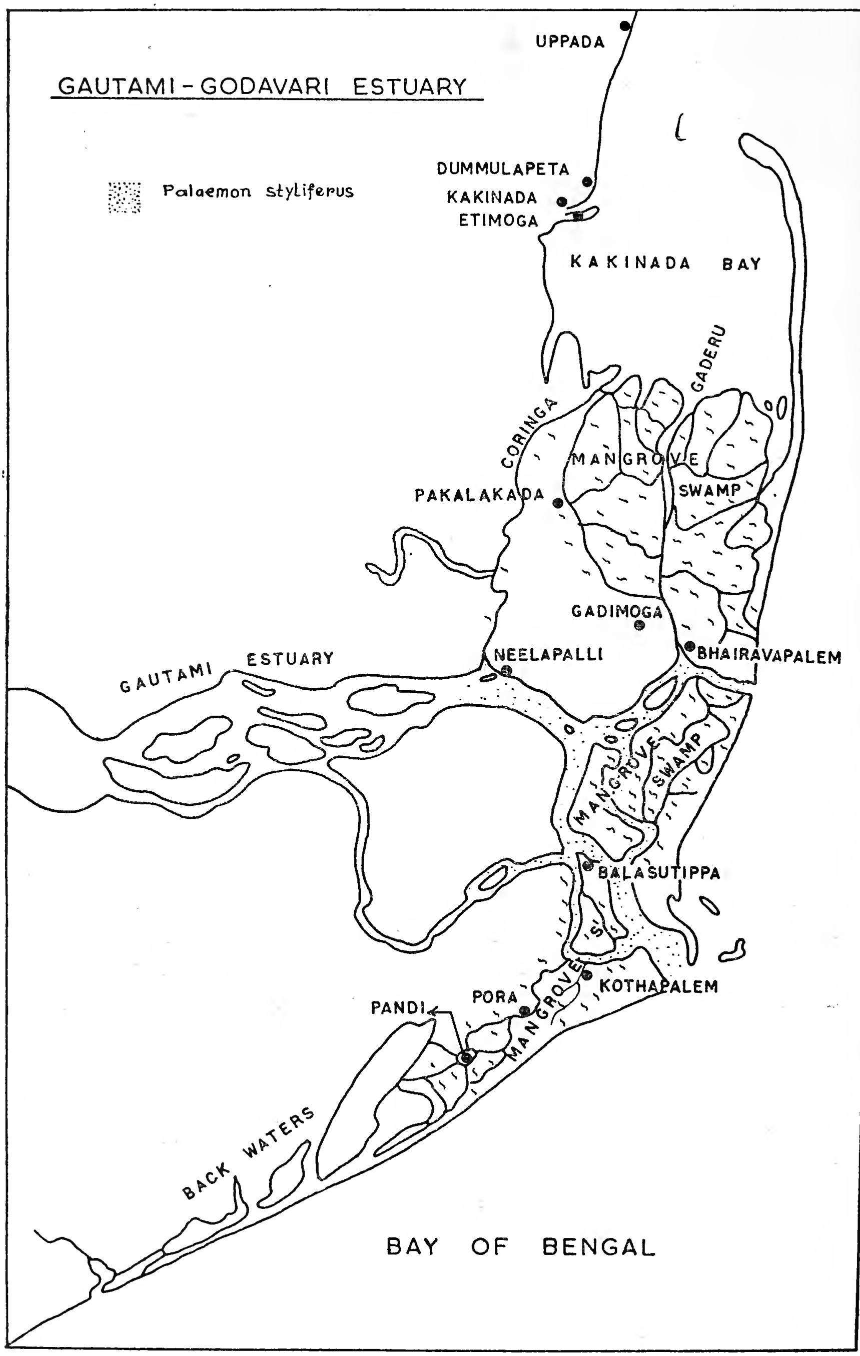

Fig. 1. Distribution of *Palaemon styliferus* in the Gautami estuary.

commercial fishery (average 0.49% in the total prawn catch). It occurs mainly in the lower reaches of the estuary almost throughout the year (Fig. 1). It was, however, found common in the month of November. Usually it appears in the commercial catches in the estuary at the close of *Palaemon tenuipes* fishing season (July to October or early November). It is the local belief that the prawn enters the estuary in large numbers with the change in the wind direction, from south-west to north-east.

The present note is intended to comparing some of the observations on the species made by Kunju (op. cit.) from the Hooghly estuary with similar observations from the Gautami-Godavari estuary. The observations are based on the data collected during the years 1960-62 from the Gautami estuary.

Materials and Methods

The prawn was collected mainly from the drag net catches made in the lower regions of the estuary during the periods, July 1960 to May 1961 and November 1961 to May 1962. The drag net operations were erratic during the intervening period and hence no data were maintained. All measurements were taken from the tip of the rostrum to the tip of the telson and were grouped with a 5 mm length interval.

Environmental conditions

The lower tidal regions are very extensive with a net work of tidal creeks, mangrove forests and backwaters. They are characterised by warm sheltered waters with plenty of cover and muddy substratum.

The salinity in the lower regions of the estuary ranged between 0.0-34.31‰. Freshwater or slightly brackishwater conditions prevailed during the monsoon months (July-October) at the surface (average salinity 6.64‰) while the bottom waters were more saline (average salinity 19.94‰). The temperature ranged between 25.2-34.0°C.

Food and feeding habits

An analysis of the contents of 16 stomachs by the frequency of occurrence method showed that organic detritus and crustaceans formed the major items of food and that the prawn appeared to be a bottom feeder by virtue of the presence of gastropod and prawn remains and sand particles (Table 1).

TABLE 1

GUT ANALYSIS OF *Palaemon styliferus*

Food items	Frequency of occurrence (%)
Organic detritus	75.01
Crustaceans (unidentified)	37.51
Sand particles	25.00
Fish remains	12.50
Penaeid prawn remains (*Metapenaeus* sp.)	12.50
Gastropod remains	6.25
Insect remains	6.25

AGE AND GROWTH

During the period of study the sizes of the prawns ranged between 16 and 120 mm. A few juveniles were available in July 1960 with a mode at 40 mm. The modal progression could be followed up to the secondary mode at 60 mm in 1960 (Fig. 2). The mode at 80 mm in

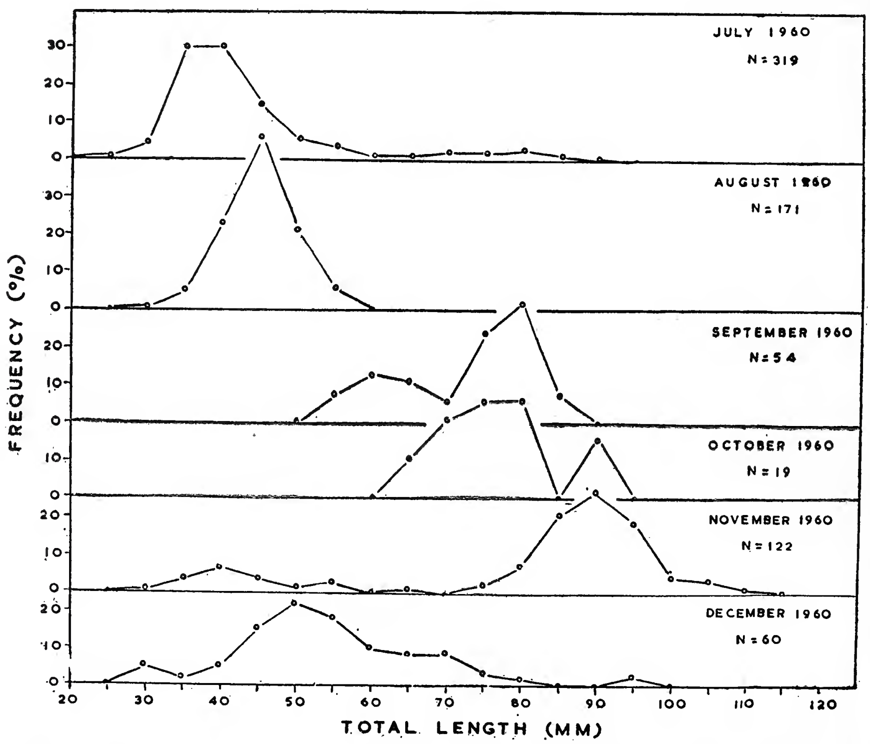

Fig. 2. Monthly size-frequency distributions of *Palaemon styliferus* from the Gautami estuary, 1960.

September 1960 shifted to 90 mm by November 1960. These progressions indicate growth rates of 10 mm/month in smaller individuals and 5 mm/month in larger individuals. In November a small mode was observed at 40 mm and the same shifted to 70 mm by March 1961 (Figs. 2-3). The average growth rate calculated from the modal pro-

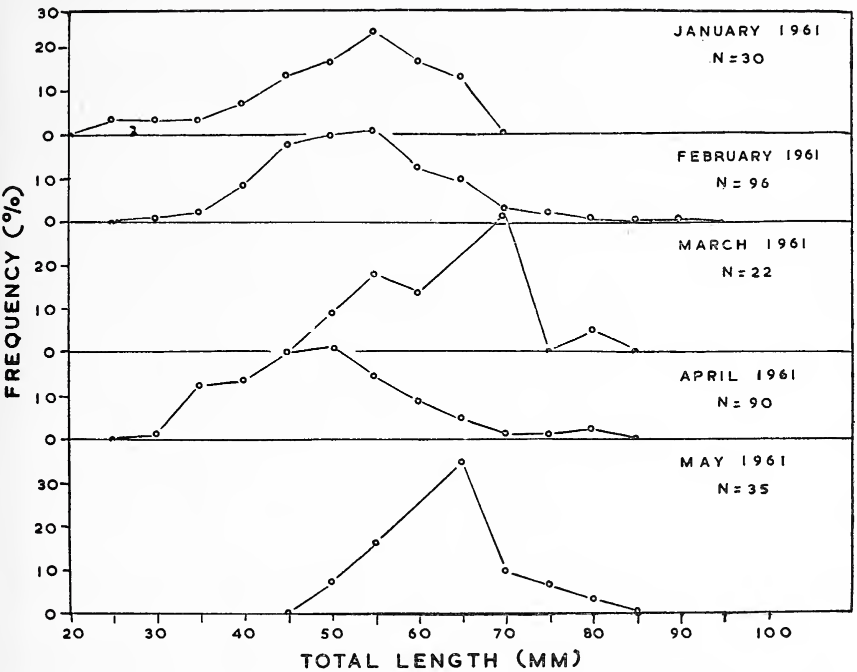

Fig. 3. Monthly size-frequency distributions of *Palaemon styliferus* from the Gautami estuary, 1961.

gression is only 7.5 mm/month. There was regression in April 1961. The size distribution in November 1961 was very much similar to the corresponding month in the previous year. Regression occurred in December and January 1962. The samples contained very few individuals during the following months (Fig. 4). The discrepancy observed in the growth rates during the two periods, from September to November 1960 and November to March 1961 is believed to be the result of continuous recruitment of juveniles during the latter period, resulting in slow progression of modes.

Breeding behaviour

In *Palaemon styliferus* the sexes could be separated on the basis of the presence (males) or absence (females) of appendix masculina on

the second abdominal appendage. The sex-ratio between the males and females was 1:11.4.

In palaemonid prawns, a special type of non-pinnate setae develop on the pleopods at the commencement of maturity and are concerned

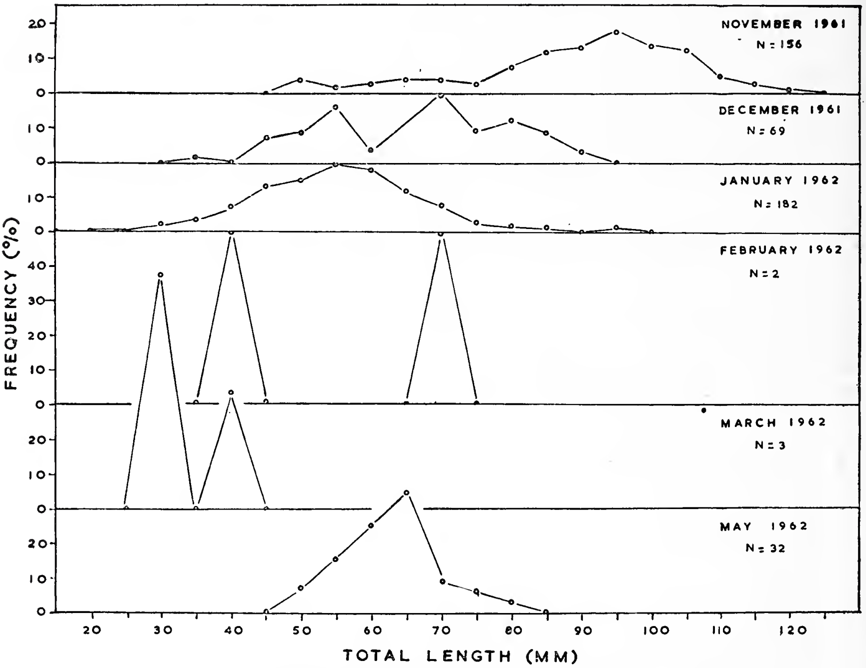

Fig. 4. Monthly size-frequency distributions of *Palaemon styliferus* from the Gautami estuary, 1961-62.

with the egg-carriage in the brood-sac (Yonge 1955). They appear as rudiments and elongate at the time of spawning. The presence of these non-pinnate setae on the pleopods (also termed as ovigerous setae or egg-bearing setae) indicates that the prawn is mature or maturing. In *Palaemon styliferus,* prawns measuring up to 75 mm were immature, without any trace of ovigerous setae. Rudimentary ovigerous setae were visible in specimens measuring over 75 mm. The smallest berried female measured 76 mm. These observations indicate that females spawn when they attain a minimum size of about 76 mm. The size of the majority of the mature females ranged between 76 and 95 mm. Mature individuals were available in large numbers during September-November period (62.96-84.61%) while the berried females were common during October-December period with a maximum in November. It thus appears that in the majority of the prawns maturation and spawning start in September and October respectively, reaching the maximum in November. Only juveniles were available during the subsequent months.

The majority of the berried females showed early embryonic development (78%) while those with eyed eggs in the brood (ready to hatch out) were very low in the samples (22%). The latter, however, showed fully developed ovary through the carapace indicating gonadial activity in berried condition. A few maulted specimens showed fully developed gonad, but the egg-bearing setae were rudimentary. Specimens with fully developed ovigerous setae were never observed. These observations reveal that the prawn may spawn more than once but a short time pause is likely, when the prawn moults twice, after hatching of the brood and before the next spawning, when the egg-bearing setae elongate to carry the eggs.

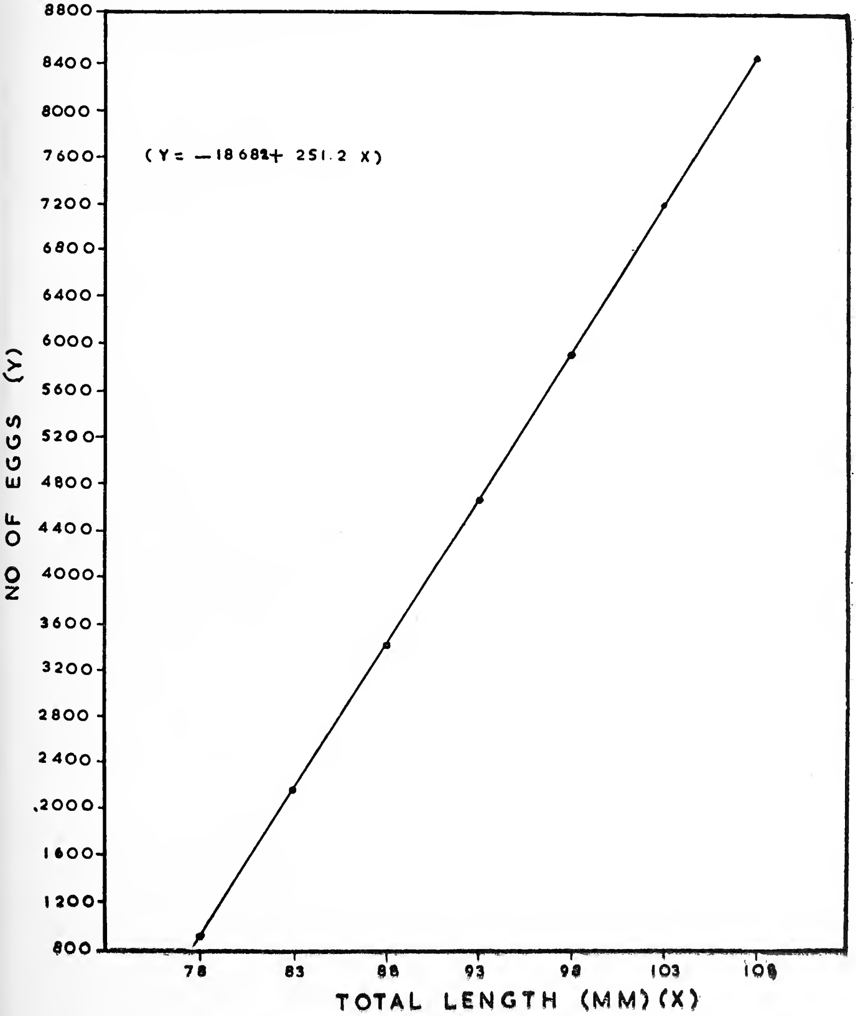

Fig. 5. Fecundity in *Palaemon styliferus.*

In 19 berried prawns, ranging between 76 and 110 mm, the number of eggs ranged between 1570 and 8640 respectively. The number of eggs in the berry showed a linear relation with the total length of the prawn (Fig. 5).

None of the prawns were parasitized.

Discussion

Palaemon styliferus is common in the Gautami-Godavary estuary in the month of November when the minimum temperature was 25.2°C and the salinity showed a rising trend after the monsoon floods. The peak fishery for this prawn in the middle zone of Hooghly estuary also coincided with minimum temperature (22.0°C) and increasing salinity (Rao 1969). The species, however, does not contribute much to the commercial fishery as in the Hooghly estuary.

The food of the prawn appears to be very much similar to its counterparts in the Hooghly estuary (Kunju loc. cit.), except for the absence of plant matter, foraminiferan shells and spicules of sponges; however, a detailed study is necessary in view of the small number of stomachs examined.

The growth rate, worked out from length frequency distribution, is estimated to range between 5 mm and 10 mm/month. On this basis, the life span of the prawn in the estuary is estimated to be about one year. By the same method Kunju (loc. cit.) and Rajyalakshmi (1964) calculated the growth rate to be 3-4 mm/month in the Hooghly estuary, which is more or less the same observed in larger individuals.

The sex-ratio is predominantly female as in the Hooghly estuary (Kunju loc. cit.). The breeding season, however, is confined to a short period in the Gautami estuary (October-December) while it is prolonged (October-July) in the Hooghly estuary (Kunju loc. cit.). Although spawning took place in the lower estuary, hatching of the brood appeared to occur only in the marine areas as no early zoeae could be recorded from the routine plankton collections. A similar condition is reported in the Hooghly estuary (Kunju loc. cit.). The prawn appears to spawn more than once during the spawning season as observed in case of the related species, *Palaemon tenuipes,* from the same estuarine system (Subrahmanyam 1971).

Although a restricted spawning period is discernible from a study of the berried females in the estuary, the size-frequency distribution indicates intermittent spawning. The juveniles encountered since November could be the progeny of the spawners of the preceding season while those encountered during the pre-monsoon months could have resulted from some spawning activity in the adjoining brackishwater or estuarine areas.

The range of berried females in the Gautami estuary is much wider than in the Hooghly estuary (68-86 mm) and the number of eggs carried by them also showed corresponding wider range. Kunju (loc. cit.) reported a number of parasitized prawns from the Hooghly estuary while none of the prawns were infested in the Gautami estuary. The reason for this is not known.

Acknowledgement

I wish to thank Prof. P. N. Ganapati, M.A., D.Sc., F.N.I., F.Z.S.I., F.A.Sc., Head of the Department of Zoology, Andhra University, Waltair, under whose guidance the present work was done.

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Contribution to the umbellifers of Kashmir[1]

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(*With twelve text-figures*)

Thirty-four species of Umbellifers belonging to the twenty-five genera are described. Keys to all the genera and species of a genus are given. Each species is described giving its diagnostic features. Localities of collection and distribution, local names and uses wherever known are also recorded. Twelve common Umbellifers in the region are illustrated.

Introduction

The family Umbelliferae is mainly distributed in Europe, North Africa, West, Central and North Asia, a few are North American, tropical and natives of Southern hemisphere. The members of the family thrive well in Kashmir as well as in other temperate zones of Western Himalayas.

The family is of great economic importance and all available members growing in Kashmir have been taken up for thorough chemical investigation by this laboratory. *Heracleum* spp. and *Ammi* spp. have given interesting results. This paper, describing the botanical aspects of the family, is the outcome of two years of field work carried out by me and is written with a view to helping those who are interested in the Umbellifers of Kashmir. It forms a further contribution to our knowledge of this family which has not received much attention from earlier workers on Kashmir flora, namely Blatter (1928), Coventry (1930) and Rao (1960, 1961).

All the specimens examined are deposited in Herbarium of this laboratory.

Abbreviations used in the text:

Blatt. Beau. Fls. Kash.	E. Blatter, BEAUTIFUL FLOWERS OF KASHMIR.
Coll. Fl. Siml.	H. Collett, FLORA SIMALENSIS.
DD	Herbarium of Forest Res. Instt., Dehra Dun.
FBI	J. D. Hooker, FLORA OF BRITISH INDIA.

[1] Accepted July 1971.

Generic key to the Umbellifers of Kashmir

1. Leaves undivided, narrow lanceolate .. *Bupleurum*
1. Leaves divided
  2. Leaves not pinnately divided
    3. Leaves 3-partite, segment 1-2 fid .. *Apium*
    3. Leaves 3-5 partite, segments spinuous .. *Eryngium*
  2. Leaves pinnately divided
    4. Fruit bristly, bristles curved or straight
      5. Fruit upto 6.4 mm diam; bristles small .. *Torilis*
      5. Fruit upto 1.5 cm diam; bristles rough and stout .. *Turgenia*
    4. Fruit not bristly (rough corrugate, style bases depressed only in *Prangos*) .. *Prangos*
      6. Leaf segments ovate to lanceolate
        7. Nodes rooting, fruit not corky .. *Oenanthe*
        7. Nodes generally free, fruit corky .. *Sium*
      6. Leaf segments much divided
        8. Fruit prolonged into a beak .. *Scandix*
        8. Fruit never beaked .. *Vicatia*
          9. Fruit ovoid or cylindrical not winged
            10. Fruit cylindrical and scabrid .. *Anthriscus*
            10. Fruit cylindrical but not scabrid .. *Chaerophyllum*
              11. Fruit ovoid with loose outer coat .. *Pleurospermum*
              11. Fruit ellipsoid, outer coat hard .. *Bunium*
                12. Leaf segments filiform or obtuse
                  13. Fruit viscid .. *Carum*
                  13. Fruit with a deep narrow longitudinal groove and not viscid .. *Conium*
                12. Leaf segments ovate or pinnatifid
                  14. Fruit ridges not distinct .. *Pimpinella*
                  14. Fruit ridges distinct, villous when young .. *Seseli*
          9. Fruit flattened, lateral ridges winged
            15. Petioles of leaflets winged .. *Ferula*
            15. Petioles of leaflets not winged
              16. Dorsal and intermediate ridges also winged, lateral wings narrow
                17. Calyx-teeth none .. *Ligusticum*
                17. Calyx-teeth lanceolate .. *Selinum*
              16. Dorsal and intermediate ridges not winged, lateral wings broad
                18. Lateral wings of 2 half fruits free
                  19. Petals entire, fruit 2 cm diam. .. *Angelica*
                  19. Petals subentire, fruit 1.5 cm diam. .. *Archangelica*
                18. Lateral wings of 2 half fruits cohering until separation *Heracleum*

Bupleurum Linn.

Glabrous herbs, rarely shrubs. Leaves entire, obovate to linear lan-

ceolate, usually sessile. Flowers yellow, pedicelled or subsessile. Fruit slightly constricted at the commissure.

KEY TO THE SPECIES

1. Leaves amplexicaule, deeply cordate, nerves 10-20, palmate .. *jucundum*
1. Leaves sessile, sometimes semiamplexicaule nerves 5-9, convergent
  2. Leaves at least 1 cm broad, usually more
    3. Fruit upto 5 cm, ridges obscure, furrows with 3 vittae .. *lanceolatum*
    3. Fruit upto 1 cm distinctly ridged, furrows with 1-3 vittae .. *candollii*
  2. Leaves upto 1 cm broad, usually less
    4. Fruit upto 2 cm distinctly ridged, furrows with 1-6 vittae .. *falcatum*
    4. Fruit ovate, ridged and slight winged, furrows with 3 vittae .. *longicaule*

B. jucundum Kurz. in Journ. Bot. 5:240, 1867; FBI 2:675.

Stem erect, somewhat woody below. Leaves amplexicaule (mostly upper ones), nerves prominent, convergent. Bract 1, upto 6 mm, ovate often amplexicaule; bracteoles 3-5. Fruit 6 mm elliptic oblong with prominent ridges, furrows with 3-vittae.

Gurcharan 1500 (30.8.70) Dachigam Rakh.

I do not place it in var. *cachemirica* (of Hooker 1879) for its lower cauline leaves are not linear oblong or linear.

The var. *cachemirica* has been reported by Duthie, J.F. from Guraize valley and Liddar valley, Kashmir. The lower cauline leaves of these specimens are linear-oblong. Duthie 12602 (6-9-1892) Guraize, 7000-8000 ft (DD); Duthie 13305 (28-7-1893) Liddar valley, Kashmir (DD).

B. lanceolatum Wall. ex DC. Prodr. 4:131, 1830; FBI 2:674.

Perennial, erect, branched herbs. Leaves overlapping towards the base, narrowly lanceolate, nerves 5-7 prominent, running parallel, converging towards the apex. Bracts acute. Fruit 3-5 mm ridges not distinct.

Rattan Chand 7110 (2.9.60) Pahalgam; Kaul RRL 5543 (2.7.69) Shopian (Rajpora orchards).

Distribution: North West Himalayas.

B. candollii Wall. ex DC. Prodr. 4:131, 1830; FBI 2:674; Coll. Fl. Siml. 208, 1900; Blat. Beau. Fls. Kash. 1:143, 1928.

Perennial tufted herb. Leaves obovate, nerves 7-9 converging towards the apex. Bracts 2-4 ovate; bracteoles absent. Fruit upto 1 cm ridged.

Kapoor 2109 (15-9-51) Drang, near Ferozpur Nalla; Kaul 19629 12.8.69). Tangmarg forest, Dachigam rakh (see fig. 10).

Distribution: Temperate Himalayas, Nepal.

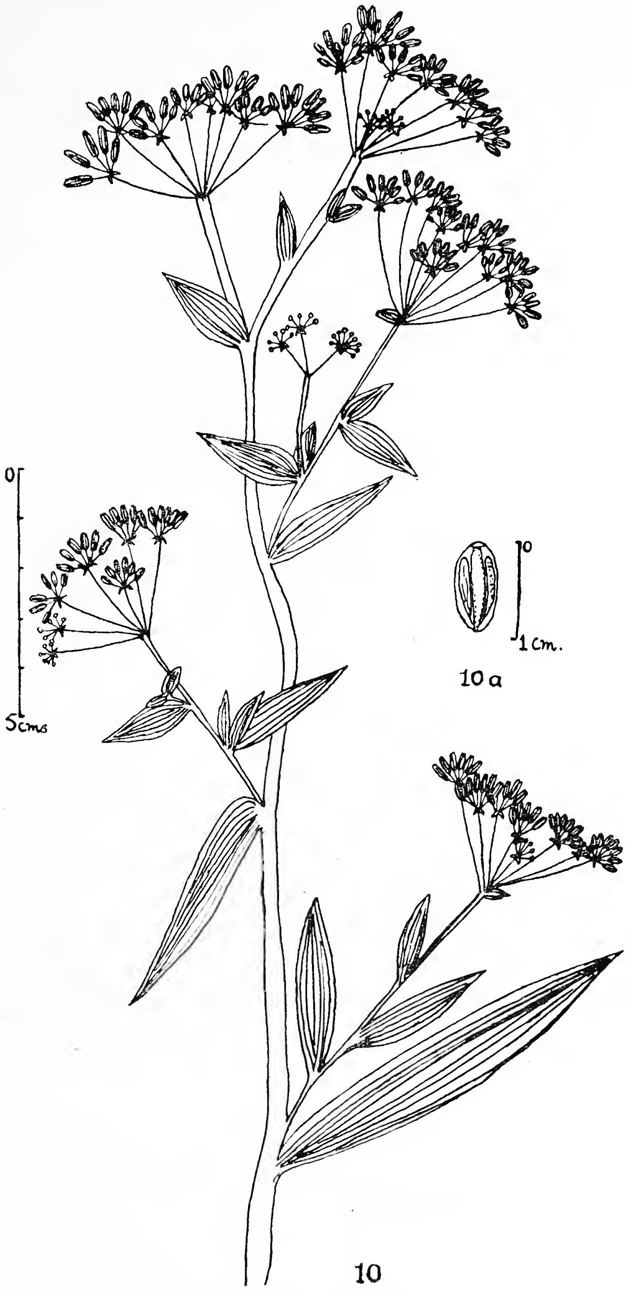

Fig. 10. *Bupleurum candollii* Wall. Flowering branch. 10a. A fruit (dorsal view).

B. falcatum Linn. var. **marginata** (Wall. ex DC.) Clarke in Hook. f.; FBI 2:676, 1879.

Annual or biennial herbs. Leaves sessile, linear upto 9 cm long, nerves 5-7 prominent. Bracts upto 5 mm linear. Flowers yellow, stalks very short. Fruit obovate, ridged, ridges with distinct furrows.

Duthie 13061 (11-7-1893) Liddar Valley 5000-6000 ft (DD); Kapoor (13-7-46) Gurez Valley; Sobti 4749 (June, 56) Gularg; Kaul 2001 (July, 69) Dachigam.

Distribution: S. Europe, West and Central Asia, temperate Himalayas, E. Asia to Japan.

B. longicaule Wall. ex DC. Prodr. 4:131, 1830; Clarke in Hook. f. FBI 2:677, 1879; Blatt. Beau. Fls. Kash. 1:142, 1928.

Stem branching from the base. Lower cauline leaves linear lanceolate, nerves not prominent, upper leaves ovate with acute apex. Bracts 1-3, bracteoles 5 prominent longer than the umbellule. Fruit 1.5 cm elliptic or egg shaped.

Keshavanand 28655 (23-8-1908) Gulmarg forests (DD); Kapoor (14-7-46) Karagbal, Gurez; Kapoor 695 (15-8-46) Kangra to Kalpani; Sobti 4746 (1-7-56) Gulmarg; Kaul 1014 (July, 69) Uri.

Distribution: Subarctic Asia; W. Siberia, Central Asia, Tibet and Western Himalayas.

Apium Linn.

Annual or perennial herbs. Leaves pinnate or 3-partite, Umbels compound often leaf opposed. Fruit slightly longer than broad.

A. graveolens Linn. Sp. Pl. 264, 1753; Clarke in Hook. f. FBI 2:679, 1879; Polunin in Fls. Europe, 285, 1969.

Leaves 3-partite, segments once or twice trifid. Flowers white. Calyx-teeth insignificant. Fruit ridges narrow, vittae broad.

Kaul 308 (25-6-1970) Majid Bagh, Barzulla Vegetable fields.

Distribution: Kabul, West and Central Asia, Europe, N. Africa, Caucasus, Afghanistan, Pakistan.

Eryngium Linn.

Perennial herbs; leaves entire or lobed. Flowers in simple heads. Fruit ellipsoidal nearly cylindric.

Key to the species

Leaves divided, segments spinous .. *billardieri*
Leaves undivided, segments not spinous .. *biebersteinianum*

E. billardieri Delaroche Eryng. 25, t. 2, 1808; FBI 2:670, Blatt. Beau. Fls. Kash. 1:141, 1928.

Stem upto 40 cm erect, branching from the base. Basal leaves long-stalked, segments 3-fid or pinnatifid, spinous-toothed. Bracts 5-7, no spines on margin bracteoles slightly spiny. Fruit upto 3 mm.

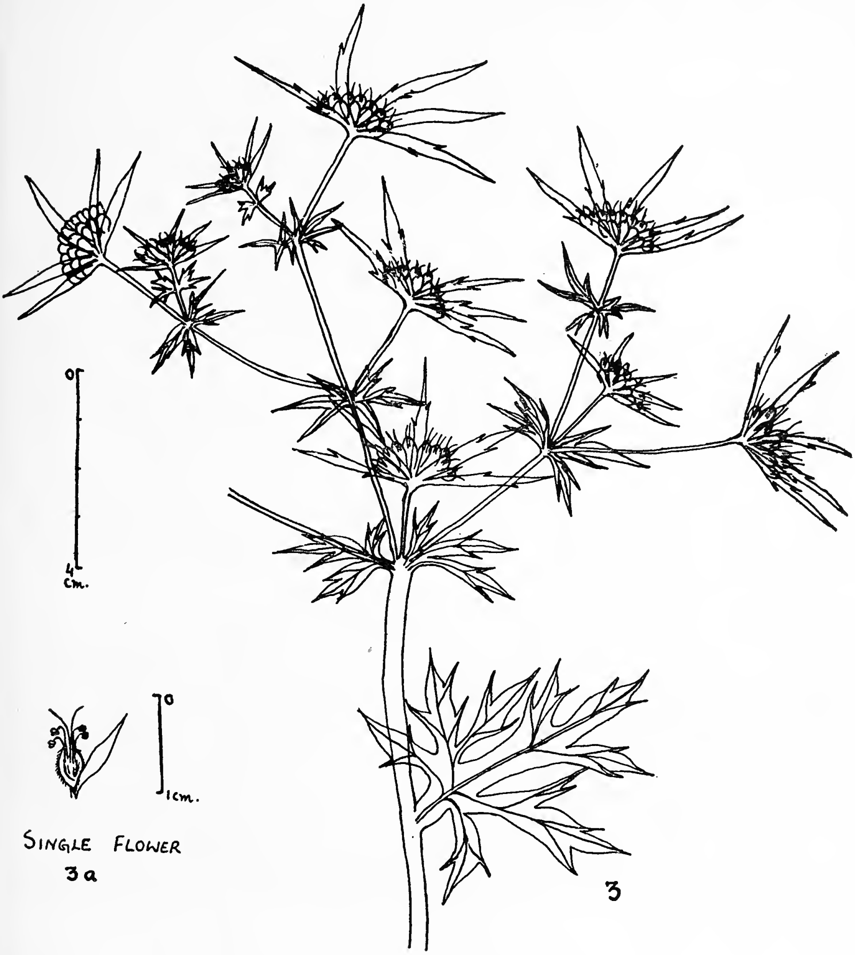

Fig. 3. *Eryngium billardieri* Delar. Flowering branch. 3a. A flower.

Dutt 7733 (27-8-62) Lal Mandi, Srinagar; Pando 8487 (July 62). University premises, Srinagar; Kaul 5595 (16-7-69) Barzulla fields, Srinagar (see fig. 3).
Distribution: Western Asia, Sind.

E. biebersteinianum Nevski ex Bobrov in Fl. USSR 16:86, 1950; Kitamua in Fl. Afghanistan, 285, 1960.
E. coeruleum Bieb. Fl. Taur. Cauc. 1:200, 1808; Clarke in FBI 2:669, 1879;

E. planum Lindl. in Royle Illust. Bot. Himal. 232, 1835 (non Linn.).

Stem upto 55 cm erect branched. Basal leaves stalked, undivided, crenate, not spiny. Bracts 5-6, slightly spiny; a few bracteoles sometimes spinous. Fruit upto 3 mm.

Gurcharan 1503 (20-7-70) Dachigam Rakh.

Distribution: Iran, Afghanistan.

Torilis Adans.

Annual herbs. Stem hispid or scabrid, generally rough. Leaves 2-4 pinnate. Bracts absent, bracteoles several. Fruit elliptic or oblong, constricted at commissure, bristly or with tubercles.

Key to the species

1. Stem rough, scabrid. Fruit densely bristly .. *leptophylla*
1. Stem glabrous or appressedly hairy. Fruit hispid .. *japonica*

T. leptophylla (Linn.) Reichb. f. in Icones, Fl. Germ. 21, t. 2010, 1866; Stewart in Catalogue of Fl. of Pakistan 527, 1972.

Caucalis leptophylla Linn. Sp. Pl. 347, 1753; FBI 2:719.

Resembling *Torilis japonica* (Houtt) DC., but the leaves are finely cut, ultimate segments narrower. Peduncles carrying the umbels very short. Fruits almost sessile, covered with straight and hooked bristles.

Kaul 167 (22-5-70) Manasbal, weed in fields.

Distribution: West Asia, South Europe, North Africa.

T. japonica (Houtt) DC. Prodr. 4:219, 1830; Raizada in Ind. For. 92 (5):299-300, 1968; Kanai in Fl. Eastern Himalayas, 231, 1966.

Caucalis japonica Houtt., Nat. Hist. 26:42, 1777; *Caucalis anthriscus* sensu Clarke in Hook. f., FBI 2:718, 1879.

Bracts absent and bracteoles 3-4 narrow, filiform. Rays 5-7 in an umbel. Flowers purplish or white.

Thapliyal 25597 (24-5-58); Kaul RRL 5544 (9-7-69); (see fig. 9).

Distribution: Himalayas, Burma, Indo-China, China, Formosa, Korea, Japan and Sumatra.

Turgenia Hoffm.

Annual hispid herbs. Leaves with oblong pinnae, hairy on undersurface. Fruit upto 1.5 mm diam. covered all over with stout, rough, curved bristles.

T. latifolia (Linn.) Hoffm. Gen. Umbell. 59, 1814; Kitamura in Fl. Afghanistan, 291, 1960.

Caucalis latifolia Linn. Syst. Nat. ed. 12, 2:1205, 1768; FBI 2:719.

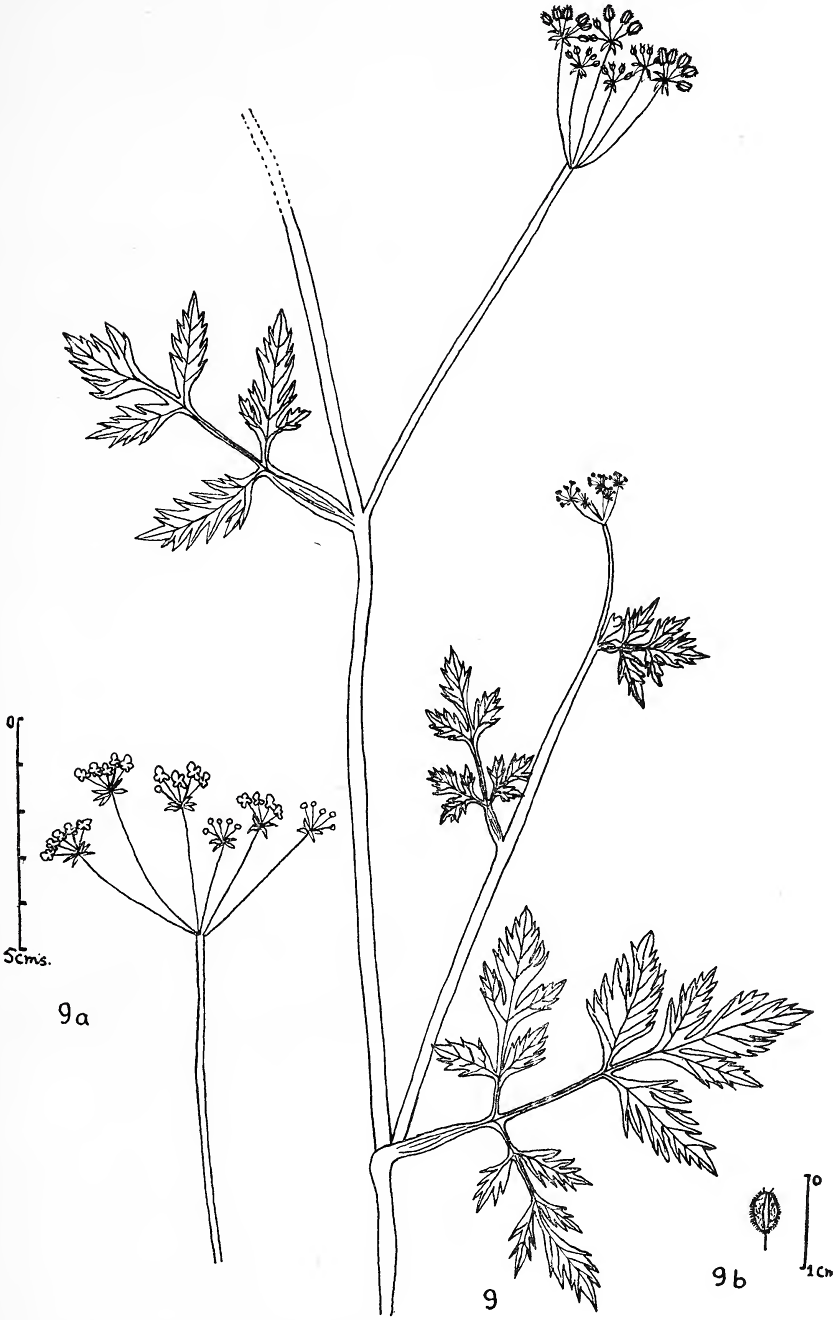

Fig. 9. *Torilis japonica* (Houtt) DC. Flowering branch. 9a. An umbel; 9b. A fruit.

Bracts absent, bracteoles linear. Rays 2-4 in each Umbel. Carpels with two lateral ridges in the form of commissures.

Kapoor 602 (15-7-46) Kashmir; Kaul 168 (22-5-70) Mansbal fields. *Distribution*: Europe, N. Africa, Caucasus, Central Asia, Asia Minor, Iran, Afghanistan.

Prangos Lindl.

Perennial herbs, Leaves 3-4 pinnate. Umbels with many bracts and bracteoles. Flowers yellow. Fruit oblong, commissure broad.

Prangos pabularia Lindl. in Quart. J. Sci. 19:7, 1825; FBI 2:719; Rao in Bull. Bot. Surv. of India 2 (3 & 4): 403, 1960.

Leaves pinnate with long filiform segments. Bracts linear. Fruit roughly corrugate between ridges. Style bases depressed.

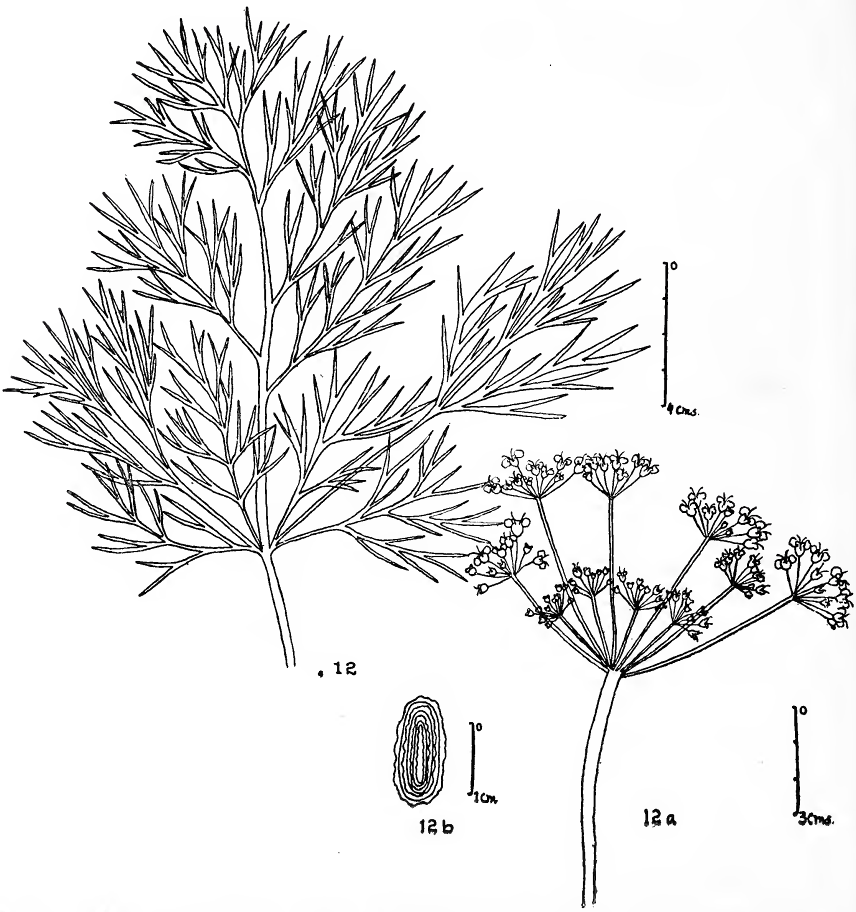

Fig. 12. *Prangos pabularia* Lindl. A leaf. 12a. An umbel with flowers. 12b. A fruit.

Duthie 13171 (24-7-1893) Liddar Valley; Kapoor 592 (13-7-46) Kamri village; Kapoor 1644 (15-6-47) Verinag top; Kapoor 2261 (28-6-52) Verinag top (see fig. 12). Local Name: Krungus. Roots are used locally to cure itch (Chopra 1956).
Distribution: Afghanistan, Pakistan.

6

Fig. 6. *Oenanthe javanica* (Bl.) DC. Flowering branch. 6a. fruit (dorsal view).

Oenanthe Linn.

Herbs with stoloniferous creeping roots, generally growing near wet places. Leaves 1-3 pinnate. Flowers white. Calyx-teeth small. Fruit ellipsoid, longer than broad.

Oenanthe javanica (Blume) DC. Prodr. 4:138, 1830; Maheshwari in Fl. Delhi, 178, t. 95, 1963.

Sium javanicum Blume Bijdr. Fl. Ned. 15:881, 1826.

O. stolonifera Wall. ex DC. Prodr. 4:138, 1830; FBI 2:696; Coll. Fl. Siml. 212, 1900.

Leaves 2-3 pinnate with oval pinnae. Fruit compressed ridged with all the ridges equal.

Kaul 85 (10-8-69), Chashma Shahi, Srinagar (see fig. 6).

Distribution: Java, China, Japan.

Sium Linn.

Leaves pinnate, pinnae toothed, Calyx teeth acute or obselete. Flowers white. Fruit ovoid or oblong, laterally compressed, constricted at the commissure.

S. latijugum Clarke in Hook. f., FBI 2:683, 1879.

Leaves pinnate compound, pinnules long narrowly lanceolate. Fruit triangular, corky, furrows 2-3 vittae.

Local name: Jangali Gajar.

Gammie s.n. (10-7-1891) Srinagar, 5300 ft. (DD); Duthie s.n. (28-9-1893), Gurez (DD); Kapoor 2101 (Sept. 61) Yarikha, Gulmarg; Kaul 19668 (11-9-69) Chashma Shahi, Srinagar (see fig. 8).

Distribution: Kashmir and Baltistan.

Scandix Linn.

Annual herbs. Umbels simple or compound. Calyx teeth minute or 0, fruit oblong, beaked.

S. pecten-veneris Linn. Sp. Pl. 256, 1753; FBI 2:692; Polunin in Fls. Europe 279, 1969.

Leaves compound, ultimate segments small, narrow, Bracts 0, fruit with a long beak.

Kaul 5945 (2-7-69) Rajpora Shopian (see fig. 7); common in Srinagar fields.

Distribution: Pakistan and Afghanistan to western Europe, Central Asia.

Fig. 8. *Sium latijugum* Clarke. A flowering branch.

Vicatia DC.

Perennial herbs. Leaves pinnately compound, ultimate segments narrow. Flowers white or pink or purple red. Fruit ovoid, narrowed at the apex, distinctly constricted at the commissure.

V. coniifolia DC. Prodr. 4:243, 1830; FBI 2:670; Coll. Fl. Siml. 207, 1900; Rao in Rec. Bot. Surv. India 18(2):32, 1960; H. Hara in Fl. Eastern Himalayas, 232, 1966.

Bracteoles linear, flowers reddish when young. Fruit with distinct ridges, small not winged.

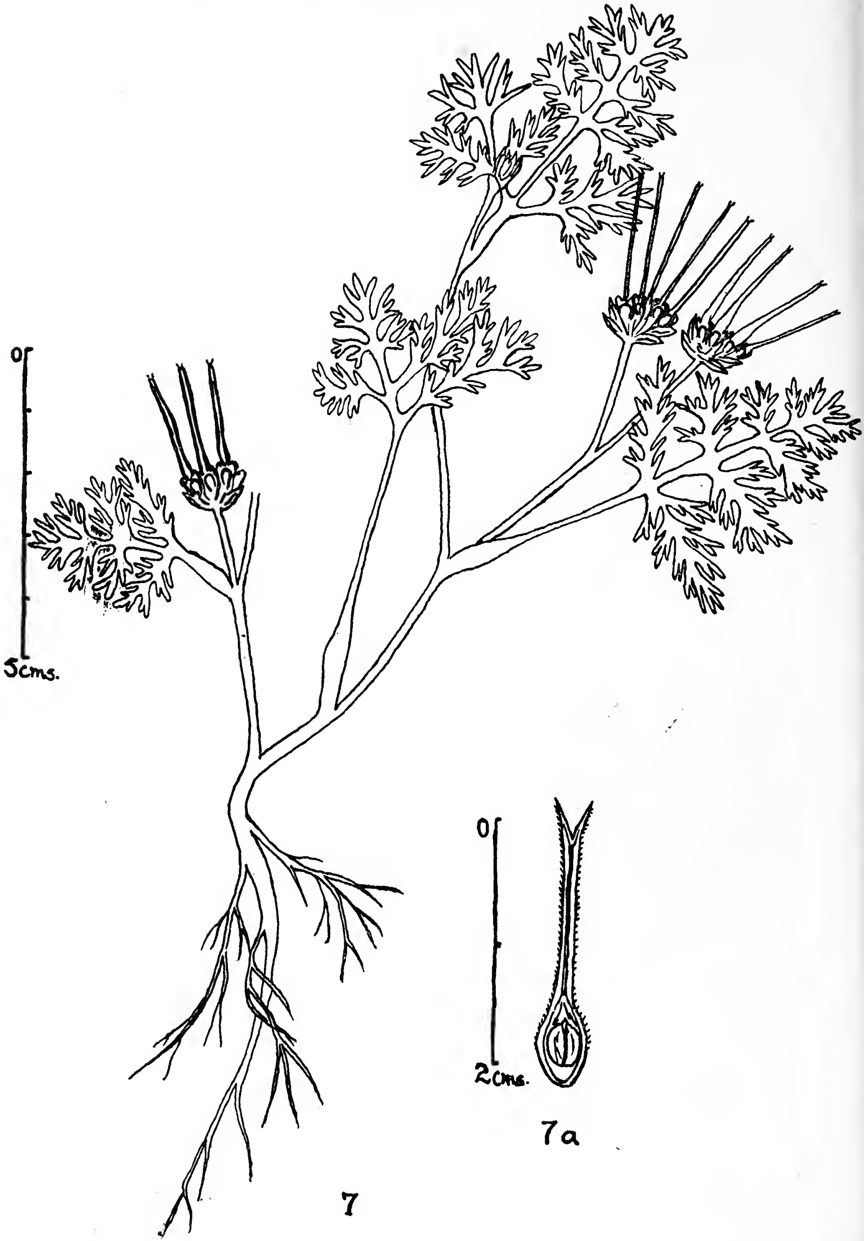

Fig. 7. *Scandix pecten-veneris* Linn. Flowering plant. 7a. fruit.

Kapoor 464 (27-6-46), Gulmarg 10,000 ft; Kapoor 659 (15-7-46), Kamri; Sarin 6629 (28-8-60) Gulmarg; Kaul 1011 (15-7-69) Rawalpora (see fig. 1).

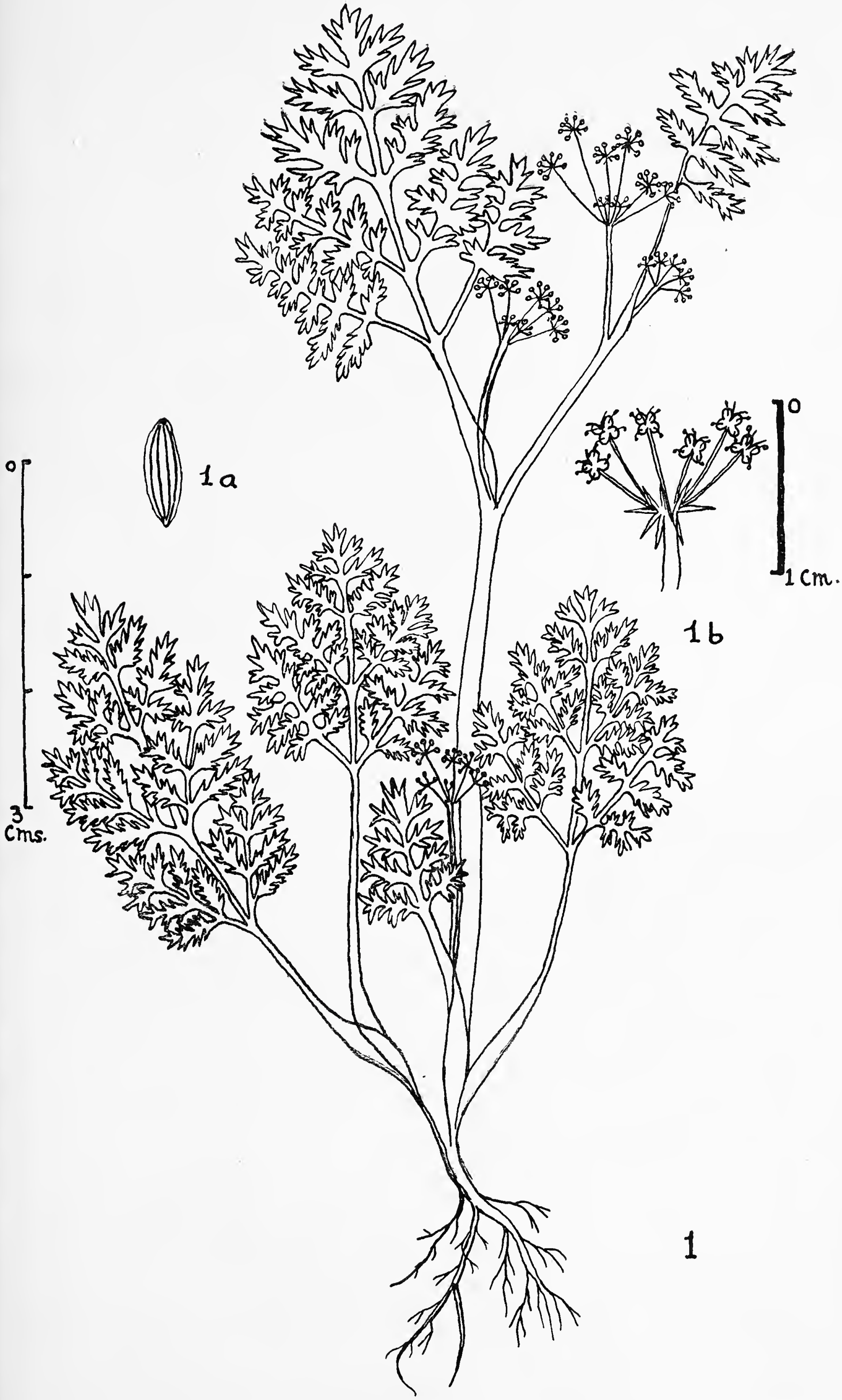

Fig. 1. *Victatia coniifolia* DC. (Flowering plant). 1a. fruit (dorsal view). 1b. an umbel.

Anthriscus Pers.

Herbs with somewhat hairy stem. Leaves 2-3 pinnate, ultimate segments toothed. Flowers white in compound umbels. Fruit oblong, narrowed at the apex, constricted at commissure, vittae solitary in each furrow.

A. nemorosa (M. Bieb.) Spreng, Pl. Umb. Prodr. 27, 1813; FBI 2:692; Coll. Fl. Siml. 212, 1900.

Chaerophyllum nemorosum M. Bieb. Fl. Taur. Cauc. 1:232, 1808.

Leafllets broad, pinnatifid, slightly pubescent beneath. Bracts none, bracteoles several. Fruit upto 1.7 cm long, cylindrical, narrowed towards apex, scabrid, ridges obscure.

Duthie 11521 (26-6-1892) Sonamarg 8000-9000 ft (DD); Duthie 13482 (7-8-1893) Liderwat 9000-10,000 ft (DD); Keshavanand 28651 (22-5-1908) Khuihama forests, Lolab (DD).

Distribution: North Asia to East Europe.

Chaerophyllum Linn.

Annual or biennial, glabrous or hairy herbs. Leaves 2-pinnate with pinnatifid pinnules; bracts 0, bracteoles present. Fruit narrowed upwards, linear, glabrous. Leaves 2-3 pinnate, ultimate segments lanceolate and obtuse.

KEY TO THE SPECIES

Stem and leaves very hairy	.. *villosum*
Stem and leaves less hairy	.. *reflexum*
Leaves 1-2 pinnate, ultimate segments oblong, mucronate	.. *capnoides*

C. villosum Wall. ex DC. Prodr. 4:225, 1830; FBI 2:690-91; Coll. Fl. Siml. 211, 1900; Rao in Rec. Bot. Surv. India 18(2):32, 1960.

Bracts absent, bracteoles 3-6, linear white margined. Fruit 2-5 cm long, somewhat broader in the middle narrowed at both ends.

Duthie 11320 (1-6-1892) above Gulmarg (DD); Kapoor 1139 (26-7-52) Naseem Bagh; Kaul 417 (12-7-69) Dachigam Rakh; Kaul 81 (27-7-69) Chashma Shahi (see fig. 5).

Distribution: Temperate Himalayas.

C. reflexum Lindl. in Royle Illus. Bot. Himal. 232, 1835; FBI 2:691; Coll. Fl. Siml. 211, 1900; Rao in Bull. Bot. Surv. India 2 (3 & 4): 403, 1960; Kanai in Fl. Eastern Himalayas, 229, 1966.

Similar to *C. villosum* with the difference that leaves are longer much more dissected and less hairy. One to three fruits mature in each umbellule.

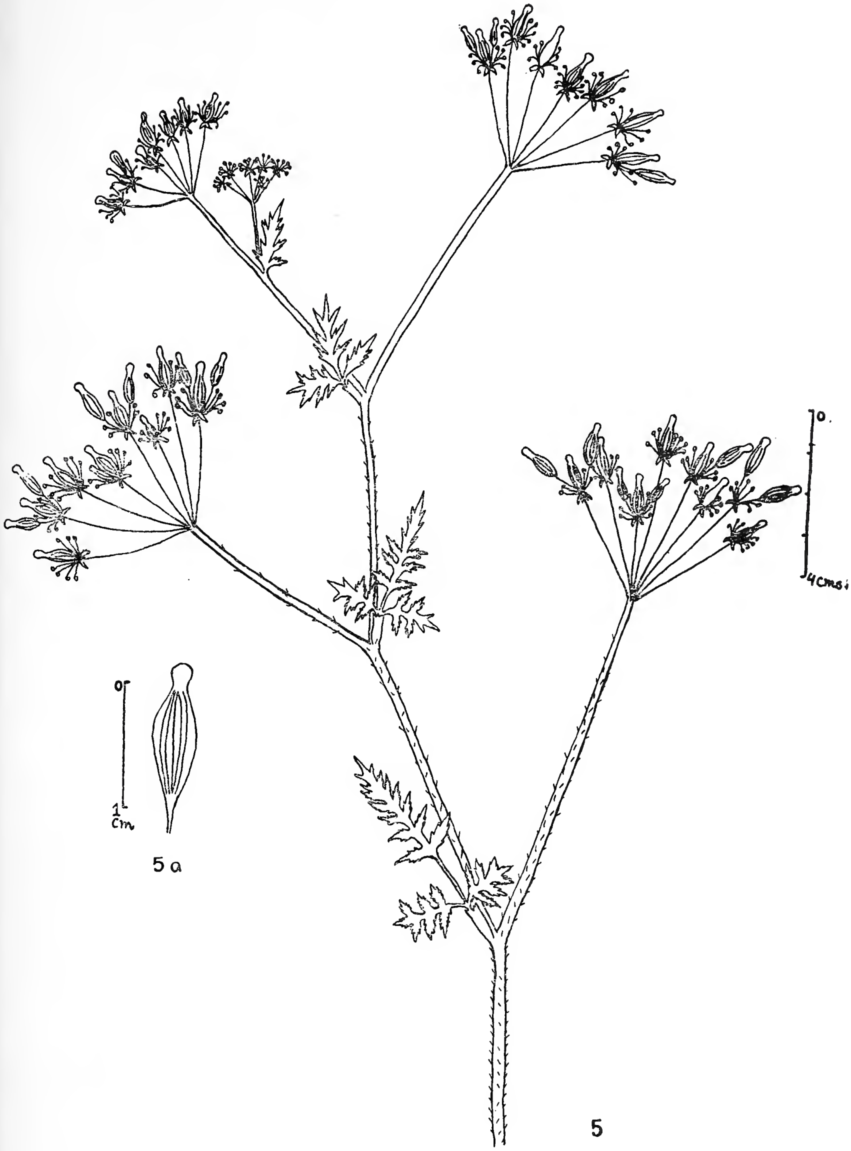

Fig. 5. *Chaerophyllum villosum* Wall. Flowering branch. 5a. fruit (lateral view).

Gammie s.n. (14-7-1891) Srinagar, 5300 ft (DD); Kapoor 431 (11-6-46) Naseem Bagh; Kaul 1015 (15-8-70) Dachigam Rakh.
Distribution: North West Himalayas; Pakistan; from Dalhousie to Kumaon; Afghanistan.

C. capnoides (Dcne.). Benth. in Gen. Pl. 1: 1867; Clarke in FBI 2:691, 1879.

Butinia capnoides Dcne. in Jacquem. V. Voy. dans. l' Independent les annees, 70, t. 80, 1828.

Bracts 0, bracteoles 4-7, oblong lanceolate; rays 4-8. Fruit 6 mm minutely punctate, very much constricted at the commissure.

Gurcharan 1505 (25-4-70) Dachigam Rakh.

Distribution: North West Himalayas.

Pleurospermum Hoffm.

Perennial or biennial herbs. Leaves 1-4 pinnate; Umbels compound. Flowers white or dark purple. Fruit elliptic or oblong.

P. stellatum Benth. in Gen. Pl. 1:915, 1867; FBI 2:702; Blatt. Beau. Fls. Kashmir 1:140, 1928.

Leaves pinnate compound with small linear lobes; fruits with a loose outer coat, furrows 1-vittae, seed grooved.

Kapoor 134 (10-7-45) Bedori.

Distribution: Alpine North Western Himalayas.

Bunium Linn.

Annual herbs. Leaves 2-3 pinnate, ultimate segments filiform. Flowers white in compound umbels. Fruit oblong or ellipsoid.

B. persicum (Boiss.) B. Fedtsch in Rastit. Turkert. 612, 1915; Kitamura in Fl. Afgh. 283, 1960.

Carum persicum Boiss. in Ann. Sci. Nat. Ser. 3, 138, 1844. *Carum bulbocastanum* auct. non Koch. (1825): FBI, 2:681; Rao in Bull. Bot. Surv. India 2 (3 & 4): 402, 1960.

Bracts linear, sometimes divided; bracteoles absent. Fruit viscid, distinctly ridged, vittae one.

Local name: Janglizera.

Kaul 19736 (30-9-1971) Barzulla orchards (see fig. 4).

Carum Linn.

Annual or perennial herbs. Leaves much divided with linear segments. Flowers white. Calyx teeth small or none. Fruit ovoid, ellipsoid or oblong, laterally compressed, generally good smelling.

C. carvi Linn. Sp. Pl. 263, 1753; Rao in Rec. Bot. Surv. Ind. 18(2): 32, 1960.

Stem procumbent or erect. Leaves much divided, ultimate segments lanceolate. Bracts 1-3, Fruit 2 mm elliptic oblong, almost viscid.

Sarin 6581 (27-6-60) Gulmarg.

Distribution: West and North Asia, Europe.

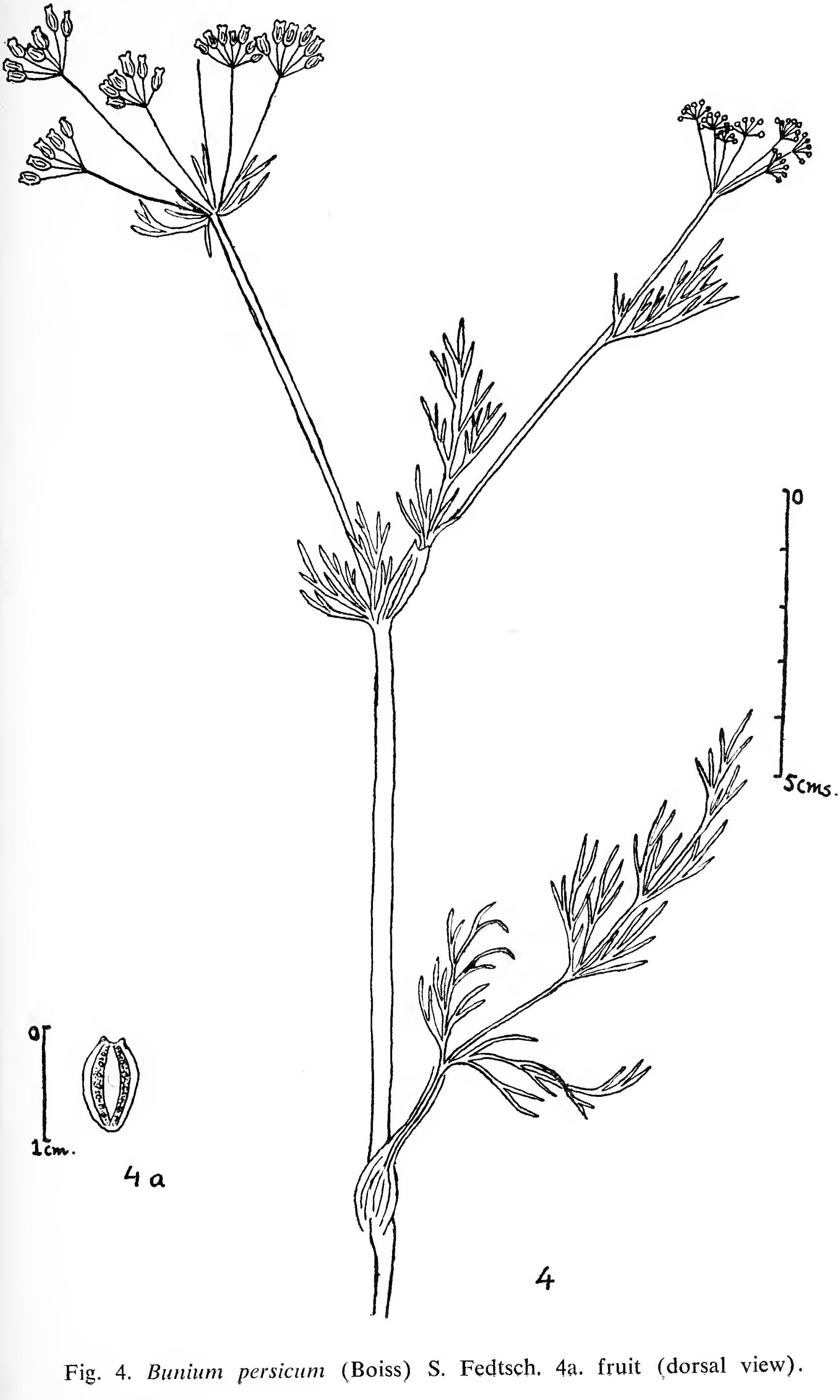

Fig. 4. *Bunium persicum* (Boiss) S. Fedtsch. 4a. fruit (dorsal view).

Conium Linn.

Fruit broadly ovoid to rounded with 5 prominent ribs; resin canals absent. Umbels compound, bracts and bracteoles few. Flowers white; Calyx absent.

C. maculatum Linn. Sp. Pl. 243, 1753; Rao in Bull. Bot. Surv. Ind. 2 (3 & 4): 304, 1960.

A smooth, purple spotted, hollow-stemmed, biennial, 1-2 metres tall plant. Leaves large, glabrous, 2-3 pinnate with segments blunt. Flowers white appearing in large showy umbels. Fruit prominently ridged and has on its inner surface a deep, narrow longitudinal groove.

Growing in waste places and other cultivated fields throughout Srinagar.

Gammie s.n. (13-7-1891), Srinagar 5300 (DD);

Kaul 5701 (12-7-70) Rainawari, Srinagar.

Pimpinella Linn.

Biennial or perennial herbs. Leaves 1-2 pinnate. Flowers in compound umbels. Calyx teeth 0, or small. Fruit laterally compressed, usually constricted at the commissure.

P. diversifolia Wall. ex DC. Prodr. 4:122, 1830; FBI 2:688; Coll. Fl. Siml. 210, 1900.

Leaves 1-pinnate; Bracts 0. Fruits narrow, hispidulous, ridges not prominent.

Hukum Singh 27154 (1-9-1907) Nagam (DD); Kapoor 176 (7-8-45) Gulmarg; Kapoor 1068 (26-6-47); Shankaracharya Hill; Kapoor 1177 (23-7-47) Banihal South Slope; Dutt 9096 (Sept. 62) Khillen Marg; Kaul 1012 (15-6-70) Harwan (see fig. 2).

Distribution: China, Afghanistan, Pakistan, Himalayas, Japan.

Seseli Linn.

Glabrous or pubescent herbs. Leaves 2-3 pinnate or twice 3-partite; flowers white. Calyx teeth minute or 0. Fruit oblong ovate or circular, not laterally compressed, broadest at the commissure.

S. sibiricum Benth. in Gen. Pl. 1:901, 1867; FBI 2:693.

Leaves 2-3 pinnate, fruits densely villous when young, dorsally compressed.

Kapoor 2275 (6-8-57) Khillenmarg; Sarin 7124 (Sept. 62) Drang, Gulmarg.

Local Name: Bhoot Keshi.

Roots yield 1% essential oil which has hypotensive action and acts as a central nervous system sedative. (Chopra 1956).

Fig. 2. *Pimpinella diversifolia* DC. (Flowering branch).

Distribution: Afghanistan, Siberia and Europe.

Ferula Linn.

Perennial herbs with enormous roots smelling powerfully. Umbels compound. Flowers yellow. Fruit orbicular or ellipsoid, much compressed dorsally, lateral ridges winged.

F. jaeschkeana Vatke. Append. in Sem. Hort. Berol. 2, 1876; Clarke in FBI 2:708, 1879; Rao in Bull. Bot. Surv. Ind. 2 (3 & 4): 403, 1960.

Leaves compound, young leaves pubescent, petioles slightly winged; fruit purplish with 3 prominent ridges on each side of the commissure.

Keshavanand 27952 (14-6-1909) Lolab; Kapoor 2272 (15-8-52) Khillenmarg; Kaul 1021 (21-7-70) Drang (se efig. 11).

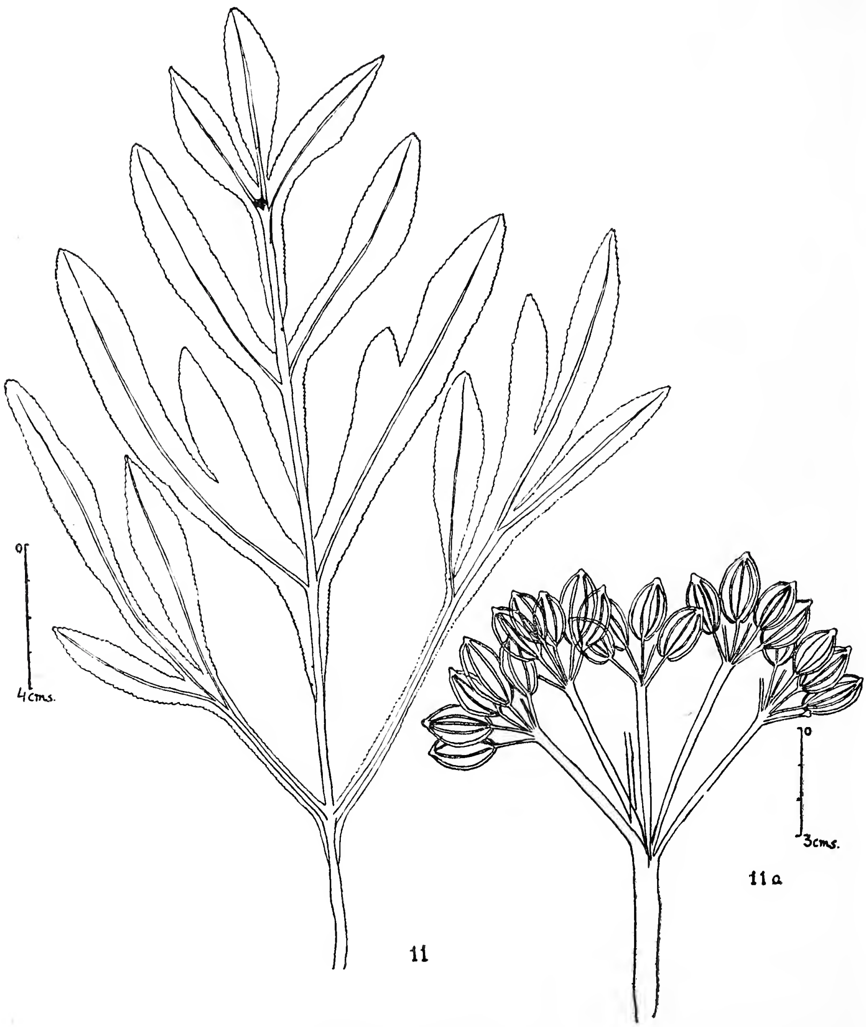

Fig. 11. *Ferula jaeschkeana* Vatke. A leaf. 11a. A fruiting umbel.

Distribution: Turkestan, Tianshan, Afghanistan.

Ligusticum Linn.

Perennial herbs. Leaves pinnate, pinnae minutely pubescent. Calyx teeth absent in flowers. Fruit ovoid ellipsoid, terete or dorsally compressed, furrows with at least 2 vittae.

L. thomsoni C.B. Clarke in Hook. f. FBI 2:698, 1879.

Leaves pinnate, pinnae oblong or ovate sometimes lobed, tough in texture, pedicels as well as leaves slightly pubescent. Flowers white. Fruit small with prominent ridges, dorsal furrows with 2-3 vittae.

Kaul 1009 (August '69) Tanmarg.

Distribution: Afghanistan.

Selinum Linn.

Perennial branched herbs. Leaves pinnate compound. Fruits ridged or not, seed plain on inner surface.

KEY TO THE SPECIES

Fruit with 3 prominent ridges	.. *tenuifolium*
Fruit with no prominent ridges, glabrous	.. *vaginatum*

S. tenuifolium (Wall. ex DC.) Clarke in Hook. f. FBI 2:700, 1879; Coll. Fl. Siml. 213, 1900; Rao in Bull. Bot. Surv. Ind. 2 (3 & 4): 403, 1960.

Bracts linear, lobed. Bracteoles many. Flowers white in compound umbels. Fruit longer than broad, prominently ridged.

Kapoor 1237 (20-7-46) Tangmarg.

In Kashmir the roots are powdered and used as condiments.

Distribution: Temperate Himalayas.

S. vaginatum C.B. Clarke in Hook. f., FBI 2:700, 1879; Coll. Fl. Siml. 213, 1900.

Leaves 1-2 pinnate, segments ovate lanceolate. Bracts linear as long as the umbellules. Flowers white in irregular compound umbels. Fruit 3 mm diam. ridges not prominent.

Bhadwar 3665 (12-8-35) Pahalgam; Bhadwar 5702 (16-8-44) Khillanmarg; Kapoor 892 (27-6-46) Pushwari, Kashmir; Kapoor 2275 (6-8-52) Drang; Kaul 1961 (8-8-69) Drang near Ferozpur Nalla.

In Kashmir the roots are used as condiments, which are often adulterated with the roots of *Seseli sibirica*. Both plants are known locally as *Bhoot Keshi* and can be easily distinguished on the basis of their habitat.

Seseli sibirica grows in rock crevices and *Selinum vaginatum* grows near moist situations.

Distribution: Kashmir to Kumaon.

Angelica Linn.

Perennial herbs. Leaves long 1-3 pinnate. Umbels compound with many rays. Calyx teeth 0, flowers white. Fruit ovoid, or ellipsoid, commissure broad, lateral ridges winged.

A. glauca Edgw. in Trans. Linn. Soc. 20:53, 1846; FBI 2:706; Coll. in Fl. Siml. 213; 1900; Rao in Rec. Bot. Surv. Ind. 18 (2): 33, 1960.

Leaves 3-pinnate, leaflets oblong. Fruits flattened, oblong, lateral ridges somewhat expanded at the top into a membranous structure.

Kapoor 876 (27-7-46) Pushwari; Kapoor (26-9-51) Gulmarg; Kapoor 2273 (5-8-52) Khilanmarg; Kaul 19631 (12-8-69) Gulmarg.

Local name: Choh'ore.

Roots locally used as a condiment after powdering. It is said to have a good cordial and stimulant value and is used in flatulence and dyspepsia.

Distribution: Western Himalayas.

Archangelica Hoffm.

Tall gigantic perennial herbs. Leaves 2-3 pinnate, pinnae large, toothed. Calyx teeth 0. Petals subentire, white. Fruit ellipsoid, subquadrate or oblong, commissure broad, lateral ones winged.

A. officinalis Hoffm. Pl. Umb. Gen. 1:162, 1814.
Angelica archangelica Linn. Sp. Pl. 250, 1753; Rao in Bull. Bot. Surv. Ind. 2 (3 & 4): 403, 1960.

Fruit oblong with three distinct middle ridges, lateral ones winged, smelling powerfully.

R. L. Bhadwar 3500 (27-7-35) Gulmarg; Kapoor 542 (10-7-46) Karghabal; Kapoor 1151 (27-7-47) Khillenmarg; Kaul 1020 (10-8-69) Gulmarg.

Distribution: N. Europe, Asia and America.

Heracleum Linn.

Perennial herbs. Leaves compound, hairy, umbels large with many rays. Flowers white. The lateral wings of the two halves of fruit cohering until separation.

Key to the species

Leaves and stem less hairy. Fruits winged .. *thomsoni*
Leaves and stem pubescent or tomentose. .. *candicans*
Fruits winged and ridged with a distinct median vittae.

H. thomsoni Clarke in Hook. f. FBI 2:711, 1879.

Bracts linear upto 2 cm bracteoles many. Umbels compound, 25-35 rays. Fruit 1 cm diam., prominently ridged, wings broad.

Kapoor 1186 (15-7-47) Banihal.

Distribution: North Himalayas.

H. candicans Wall. ex DC. Prodr. 4:135, 1830; FBI 2:714; Coll. in Fl. Siml. 215, 1900; Rao in Bull. Bot. Surv. Ind. 2 (3 & 4): 403, 1960.

Umbels compound, 30-40 rays. Fruit 1-3 cm diam. ridges prominent with distinct median vittae.

Kaul 5568 (9-6-69) Tangmarg forests; Kaul 19637 (12-8-69) Gulmarg.

Local name: 'Krandel'.

Roots and seed with strong smell. Milky juice comes out of roots on injury.

The roots of the plants are commercially exploited for the production of Xanthotoxin and as such the plant is economically of much importance.

Distribution: North Himalayas.

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Communal roosting habits of Indian Birds[1]

MADHAV GADGIL[2] AND SALIM ALI

(*With two text-figures*)

INTRODUCTION

A number of bird species of diverse orders and families and with a diversity of habits and habitats roost together for at least a part of the year. In a few cases such social roosting may be a simple consequence of the paucity of suitable roosting sites forcing the birds to crowd together. However, in a majority of cases of communal roosting the birds associate together through some social attraction and do not disperse even if alternative roosting sites are available. Some of these social groups merely comprise feeding or migratory flocks which remain together outside the roosting time as well. Leaving aside these cases, there are a number of bird species which voluntarily form new social groups specifically at the time of roosting. In this paper we will restrict our attention mainly to the latter type of communal roosting.

Although a number of accounts of Indian birds make incidental references to the roosting habits, no systematic account of this phenomenon has as yet been presented. In fact, the various published accounts of communal roosting are all based on examples selected to illustrate a particular point and we are not aware of any account which deals with the avifauna of any region as a whole (Wynne-Edwards 1962, Ward 1965, Zahavi 1971, Gadgil 1972, Ward & Zahavi 1973). The present paper aims to provide a summary of some of the commoner species included in Ali (1972) based primarily on our field experience. Numerous other examples of such communal roosters could be cited if the entire Indian avifauna as listed in Ripley (1961) were taken into account. This summary is followed by an attempt to show that such birds as roost communally in the sense defined above, contrast in certain ecological characteristics with those which do not do so. Finally, we examine the implications of these characteristics from the viewpoint of the various functions that have been attributed to the habit of communal roosting.

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Systematic Account

This account is restricted to a few of those species of Indian birds which, seasonally or at least occasionally, form communal roosts with a membership larger than a foraging or migratory flock. The name of each species, preceded by R or M (Resident or Migrant) and a sequential number, is followed by the following information:

(a) Whether the habit of communal roosting is constant throughout the year—C, or seasonal—Z.

(b) Whether, when formed, the communal roost is small in size—S, i.e. it includes five to twenty individuals; or of medium size—M, i.e. of several tens of individuals; or large—L, i.e. of several hundred individuals; or enormous—E, i.e. of several thousand individuals. Note that this refers to the number of individuals of that particular species only, and not to the overall size of the communal roost if it is a mixed one comprising several species.

(c) Whether the roost includes members of only one species, i.e. if it is pure—P; or of members of other species as well, i.e. it is a mixed roost—X.

(d) If the species associates with other species in forming a mixed communal roost, then the sequential number of the species it occurs with: thus 39 implies House Crow, 21 implies Rose-ringed Parakeet, and so on. In this list of associates at a mixed roost only the significant associates are noted. Thus the Rosy Pastor is a significant associate of the Redheaded Bunting but not *vice versa*.

Order PELECANIFORMES
Family PHALACROCORACIDAE Cormorants and Darter

R 1 Large Cormorant, *Phalacrocorax carbo* (Linnaeus)
(a) C; (b) S-M; (c) X; (d) 2, 3, 4, 7

R 2 Indian Shag, *Phalacrocorax fuscicollis* Stephens
(a) C; (b) S-M; (c) X; (d) 1, 3, 4, 7

R 3 Little Cormorant, *Phalacrocorax niger* (Vieillot)
(a) C; (b) S-M; (c) X; (d) 1, 2, 4, 7

R 4 Darter, *Anhinga rufa* (Daudin)
(a) C; (b) S; (c) X; (d) 1, 2, 3, 7

Order CICONIIFORMES
Family ARDEIDAE Herons, Egrets, etc.

R 5 Pond Heron, *Ardeola grayii* (Sykes)
(a) C; (b) S; (c) X; (d) 3, 6, 7, 39

R 6 Cattle Egret, *Bubulcus ibis* (Linnaeus)
(a) C; (b) S; (c) X; (d) 3, 7, 39

R 7 Little Egret, *Egretta garzetta* (Linnaeus)
(a) C; (b) S-M; (c) X; (d) 3, 5, 6, 39

R 8 Night Heron, *Nycticorax nycticorax* (Linnaeus)
(a) C (diurnal); (b) S-M; (c) P; (d) —

Order FALCONIFORMES
Family ACCIPITRIDAE Hawks, Vultures, etc.

R 9 Honey Buzzard, *Pernis ptilorhynchus* (Temminck)
(a) Z; (b) S; (c) P; (d) —

R 10 Pariah Kite, *Milvus migrans* (Boddaert)
(a) Z; (b) S-M; (c) P; (d) —

R 11 Blackwinged Kite, *Elanus caeruleus* (Desfontaines)
(a) Z; (b) S; (c) P; (d) —

R 12 Brahminy Kite, *Haliastur indus* (Boddaert)
(a) Z; (b) S; (c) P; (d) —

R 13 White Scavenger Vulture, *Neophron percnopterus* (Linnaeus)
(a) Z; (b) S; (c) P; (d) —

R 14 Whitebacked Vulture, *Gyps bengalensis* (Gmelin)
(a) C; (b) S; (c) P; (d) —

Order GALLIFORMES
Family PHASIANIDAE Pheasants, Partridges, etc.

R 15 Red Junglefowl, *Gallus gallus* (Linnaeus)
(a) C; (b) S; (c) P; (d) —

R 16 Grey Junglefowl, *Gallus sonneratii* Temminck
(a) C; (b) S; (c) P; (d) —

Order GRUIFORMES
Family RALLIDAE Rails, Coots, etc.

R 17 Purple Gallinule, *Porphyrio porphyrio* (Linnaeus)
(a) C; (b) S-M; (c) P or X; (d) 46, 48 and some other reed bed roosters.

Order COLUMBIFORMES
Family COLUMBIDAE Pigeons and Doves

R 18 Blue Rock Pigeon, *Columba livia* Gmelin
(a) C; (b) S-L; (c) P; (d) —

R 19 Ring Dove, *Streptopelia decaocto* (Frivaldszky)
(a) C; (b) S; (c) P; (d) —

Order PSITTACIFORMES
Family PSITTACIDAE Parrots

R 20 Large Indian Parakeet, *Psittacula eupatria* (Linnaeus)
(a) C; (b) S-L; (c) P; (d) —

R 21 Roseringed Parakeet, *Psittacula krameri* (Scopoli)
(a) C; (b) L-E; (c) X; (d) 36, 39

Order APODIFORMES
Family APODIDAE Swifts

R 22 Alpine Swift, *Apus melba* (Linnaeus)
(a) C; (b) M-L; (c) P; (d) —
R 23 House Swift, *Apus affinis* (J. E. Gray)
(a) C; (b) S-M; (c) P; (d) —

Order CORACIIFORMES
Family MEROPIDAE Bee-eaters

R 24 Chestnutheaded Bee-eater, *Merops leschenaulti* Vieillot
(a) C; (b) S; (c) P; (d) —
R 25 Bluecheeked Bee-eater, *Merops superciliosus* Linnaeus
(a) C; (b) S-M; (c) P; (d) —
R 26 Small Green Bee-eater, *Merops orientalis* Latham
(a) C; (b) S-M; (c) P; (d) —

Family BUCEROTIDAE Hornbills

R 27 Great Pied Hornbill, *Buceros bicornis* Linnaeus
(a) Z; (b) S-M; (c) P; (d) —
R 28 Grey Hornbill, *Tockus birostris* (Scopoli)
(a) Z; (b) S; (c) P; (d) —

Order PASSERIFORMES
Family HIRUNDINIDAE Swallows

M 29 Redrumped Swallow, *Hirundo daurica* Linnaeus (Migratory forms)
(a) Z; (b) L-E; (c) X; (d) 30, 46
M 30 Common Swallow, *Hirundo rustica* Linnaeus
(a) Z; (b) L-E; (c) X; (d) 29, 46, 48
R 31 Cliff Swallow, *Hirundo fluvicola* Blyth
(a) Z; (b) S-M; (c) X; (d) 29, 30, 46
R 32 Wiretailed Swallow, *Hirundo smithii* Leach
(a) Z; (b) S; (c) X; (d) 29, 30, 31, 46

Family STURNIDAE Starlings, Mynas

R 33 Brahminy Myna, *Sturnus pagodarum* (Gmelin)
(a) C; (b) S-M; (c) ± P; (d) —
M 34 Rosy Pastor, *Sturnus roseus* (Linnaeus)
(a) Z; (b) L-E; (c) X; (d) 21, 36, 37, 39, 49, 51
R 35 Pied Myna, *Sturnus contra* Linnaeus
(a) C; (b) S-M; (c) ± P; (d) —
R 36 Indian Myna, *Acridotheres tristis* (Linnaeus)
(a) C; (b) M-L; (c) X; (d) 21, 39
R 37 Jungle Myna, *Acridotheres fuscus* (Wagler)
(a) C; (b) S; (c) X; (d) 36
R 38 Bank Myna, *Acridotheres ginginianus* (Latham)
(a) C; (b) S-M; (c) ± P; (d) —

Family CORVIDAE Crows, Jays, Magpies, etc.

R 39 House Crow, *Corvus splendens* Vieillot

(a) C; (b) L; (c) X; (d) 6, 21, 36, 40
R 40 Jungle Crow, *Corvus macrorhynchos* Wagler
(a) C; (b) M; (c) X; (d) 6, 36, 39

Family PYCNONOTIDAE

R 41 Redwhiskered Bulbul, *Pycnonotus jocosus* (Linnaeus)
(a) Z; (b) S; (c) ± P; (d) —
R 42 Whitecheeked Bulbul, *Pycnonotus leucogenys* (Gray)
(a) Z; (b) S; (c) ± P; (d) —
R 43 Redvented Bulbul, *Pycnonotus cafer* (Linnaeus)
(a) Z; (b) S; (c) ± P; (d) —

Family MUSCICAPIDAE
Subfamily Timaliinae Babblers

R 44 Jungle Babbler, *Turdoides striatus* (Dumont)
(a) C; (b) S; (c) P; (d) —
R 45 Common Babbler, *Turdoides caudatus* (Dumont)
(a) C; (b) S; (c) P; (d) —

Family MOTACILLIDAE Pipits, Wagtails

M 46 Yellow Wagtail, *Motacilla flava* Linnaeus (several subspecies)
(a) Z; (b) L-E; (c) X; (d) 29, 30, 31, 32, 48, 58, 59
M 47 White Wagtail, *Motacilla alba* Linnaeus (two subspecies)
(a) Z; (b) M; (c) P or X; (d) 46
M 48 Yellowheaded Wagtail, *Motacilla citreola* Pallas (two subspecies)
(a) Z; (b) S-L; (c) P or X; (d) 30, 46

Family PLOCEIDAE Weaver Birds
Subfamily Passerinae Sparrows

R 49 House Sparrow, *Passer domesticus* (Linnaeus) and migratory subspp.
(a) C or Z; (b) M-E; (c) P or X; (d) 34, 50, 58, 59
R 50 Yellowthroated Sparrow, *Petronia xanthocollis* (Burton)
(a) C; (b) S-M; (c) P or X; (d) 49

Subfamily Ploceinae Weaver Birds

R 51 Baya Weaver Bird, *Ploceus philippinus* (Linnaeus)
(a) C; (b) L-E; (c) P or X; (d) 34
R 52 Blackthroated Weaver Bird, *Ploceus benghalensis* (Linnaeus)
(a) C; (b) L; (c) ± P; (d) —
R 53 Streak Weaver Bird, *Ploceus manyar* (Horsfield)
(a) C; (b) L; (c) ± P; (d) —

Subfamily Estrildinae Munias

R 54 Whitethroated Munia, *Lonchura malabarica* (Linnaeus)
(a) C; (b) S-M; (c) ± P; (d) —
R 55 Whitebacked Munia, *Lonchura striata* (Linnaeus)
(a) C; (b) S-M; (c) ± P; (d) —
R 56 Spotted Munia, *Lonchura punctulata* (Linnaeus)

Family FRINGILLIDAE Finches

Subfamily Carduelinae Goldfinches and allies

M 57 Rosefinch, *Carpodacus erythrinus* (Pallas)
(a) Z; (b) S-M; (c) $\pm$ P; (d) —

·Family EMBERIZIDAE Buntings

M 58 Blackheaded Bunting, *Emberiza melanocephala* Scopoli
(a) Z; (b) M-L; (c) X; (d) 34, 46, 49, 59

M 59 Redheaded Bunting, *Emberiza bruniceps* Brandt
(a) Z; (b) M-L; (c) X; (d) 34, 46, 49, 58

ECOLOGICAL CORRELATES

This tentative set of bird species which roost communally clearly includes species with very diverse habits. It includes birds of marshes and jheels, open grasslands, cultivation, scrub and forests; birds which are purely graminivorous, insectivorous as well as omnivorous, predators, and scavengers. Not only do birds of such diverse habits share in common the habit of communal roosting, but birds with very similar habits may differ from each other in this regard. Thus the Roseringed and Large Indian Parakeets (*Psittacula krameri* and *P. eupatria*) roost communally whereas the Blossomheaded Parakeet (*P. cyanocephala*) presumably does not. Nevertheless a more detailed examination of the data reveals that there are certain general, though maybe only statistical trends. For this purpose we contrasted the distribution of certain characteristics of the fifty-nine species listed above, with the distribution of these characteristics amongst the non-communal roosters included in Ali (1972). The latter list was taken as a fair representation of the common bird fauna as a whole, though it may overemphasize plains (*v.* hill) birds and species found near human habitation. A number of characteristics namely habitat, nature of food, nature of foraging group scrubland and cultivation is markedly greater and the proportion of birds of more wooded habitats markedly smaller amongst the communally roosting species was found to differ suggestively from the set of non-communal roosters in particular with respect of the nature of the habitat and of the foraging group (see fig. 1).

The proportion of birds of aquatic habitat is not very different between the non-communal and the communal roosters. However, the proportion of birds of more open terrestrial habitats such as grasslands, scrubland and cultivation is markedly greater and the proportion of birds of more wooded habitats markedly smaller amongst the communally roosting birds. A further examination of the data shows that the bird species forming large or enormous communal roosts such as the Baya Weaver Bird, Rosy Pastor or Indian Myna all belong to open habitats, while the species of the communal roosters of the more thickly wooded habitats such as the Great Indian Hornbill and the Jungle-

fowl do not roost communally as a constant feature, i.e. do so only seasonally and usually form pure, not mixed roosts.

The second clearcut difference between the communal and the non-communal roosters is in the nature of feeding groups. It will be noted that the proportion of solitary feeders, and even more strikingly the proportion of bird species feeding in pairs, is markedly smaller and the proportion of flock feeders markedly greater amongst the communal roosters. Most of the species feeding in pairs are resident species and it is very likely that these birds are pair-bonded and territorial on a year-round basis. The incompatibility of territoriality with communal roosting may be the cause of the near-absence of birds feeding in pairs amongst the communally roosting birds.

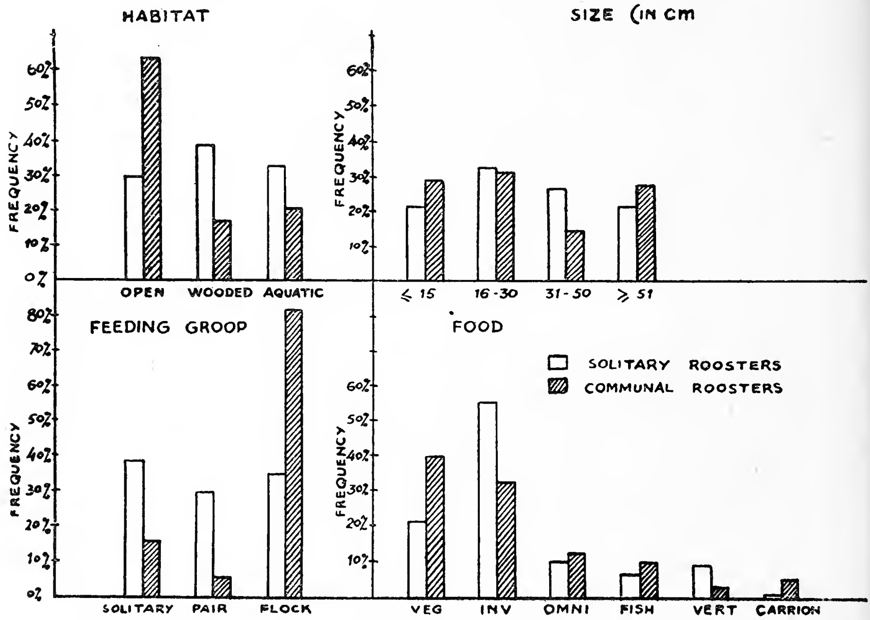

Fig. 1. Differences in the frequency of different attributes amongst the set of species which roost in a non-communal fashion, and the set of species which roost communally. The food categories represented are (i) Vegetable matter, i.e. seeds, grains, shoots, fruit and berries; (ii) Invertebrates including insects, molluscs etc. (iii) Omnivorous feeding habits. Although most bird species are omnivorous in a litteral sense, only those whose diet regularly includes substantial amounts of both plant and animal food are included. (iv) Fish. (v) Vertebrates other than fish, particularly lizards, rodents and other birds and (vi) Carrion.

Thirty-three of the fifty-nine bird species that roost communally form roosts restricted to a single species, i.e. pure roosts. It is notable that these roosts are almost always of a small size. Only in the case of Blue Rock Pigeon and the Large Indian Parakeet are large pure roosts oc-

casionally formed. It is also possible that the large roosts of Black-breasted and of Streaked Weaver Bird are also more or less pure roosts; but this needs to be confirmed by further field observations. On the contrary in the six cases where enormous roosts are formed, the roosts are invariably of a mixed nature. The various associates at a mixed roost may be of similar feeding habits as in the case of three species of wagtails roosting together, or may be of very dissimilar feeding habits as is the case with the association of the House Crow, the Cattle Egret and the Roseringed Parakeet. Fig. 2 presents an analysis of the data from this view point. It shows that a mixed roost is almost equally likely to be made up of species of dissimilar as of similar feeding habits.

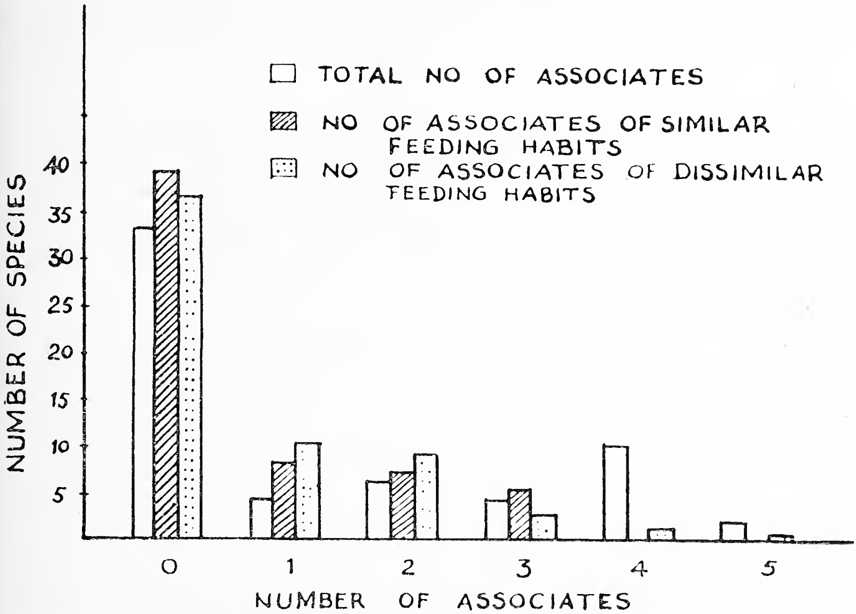

Fig. 2. Number of communal roosters with different numbers of significant associates. Thus thirty-three species form pure communal roosts; thirty-nine species have no associate of similar feeding habits; ten species have one associate of dissimilar feeding habits; ten species have a total of four other associates (whether of similar or dissimilar feeding habits) and so on.

Functional significance

Recently a number of interesting suggestions have been made as to the nature of the advantage conferred on birds participating in communal roosting. The four major hypotheses in this respect are: (a) Communal roosting enables birds to conserve heat (b) Communal roosting enables birds to assess population densities which are then adjusted to the prevailing level of food supply through emigration and adjustment

of reproductive rate (c) Communal roosting serves the function of communication of information regarding the location of food sources (d) Communal roosting enables birds to reduce the risk of predation.

Although it is likely that more than one of these functions may be simultaneously served by communal roosting, the best method of testing the various alternative hypotheses is to try to generate predictions on the supposition that any one of them is the primary function. Thus on hypothesis (a) Communal roosting will be most prevalent amongst birds most susceptible to heat loss. On this supposition communal roosting should be commoner amongst birds of higher latitudes and altitudes. This is probably not true, though our data does not lend itself to testing this. It does, however, lend itself to another test. Small birds must be more susceptible to heat loss because of their greater surface to volume ratio. We may therefore expect communal roosting to be commoner amongst the smaller birds. A comparison of the distribution of size between the communal and non-communal roosters however reveals only a slight bias towards smaller birds amongst the former. Also the ambient temperature is unlikely to produce vital changes under Indian conditions. We may therefore tentatively reject the hypothesis that heat conservation is the primary function of communal roosting amongst Indian birds.

The second hypothesis, namely that communal roosts serve the function of assessment of population density was first put forward by Wynne-Edwards (1962) and has aroused considerable controversy. The major objection to this hypothesis lies in its inconsistency with the principle of natural selection. We may however ignore this and see if we can derive any testable predictions from the hypothesis. The need for an assessment of population density to be adjusted to the food supply must be greatest where the populations achieve levels close to those supported by food supplies. Such species are the so called K-strategists (MacArthur 1962, Cody 1966, Gadgil & Solbrig 1972). We may therefore predict that according to the Wynne-Edwardsian hypothesis, communal roosting will be commoner amongst birds from less harsh, more equable environments. A number of comparisons such as those suggested by Cody (1966) may be made to test this. Our data lends itself to one such test. We may on the whole expect that wooded habitats provide a less harsh environment as compared to open habitats. Then, we may expect communal roosting to be commoner amongst birds of wooded as opposed to open habitats. Our data does not support this hypothesis.

The phenomenon of mixed roosting also poses difficulties for this hypothesis. If the communal roost serves the function of assessment of population density in relation to the level of food supply, then the assessment of the density of the population of another species could

serve no useful function, unless that species also has very similar feeding habits. Wynne-Edwards (1962) does in fact contend that species of dissimilar feeding habits associate in mixed roosting only in rare cases. However our data shows this claim to be false; in fact an associate species is, if anything, more likely to be of dissimilar than of similar feeding habits (fig. 2).

The third and the most novel hypothesis, namely that communal roosts serve as centres for the exchange of information regarding the location of food sources was first put forth by Ward (1965) (see also Zahavi 1971, Ward & Zahavi 1973). If a species feeds on rather patchy and temporary food sources, then the individuals of that species need to find new food sources continually. If a flock that has discovered a good patch of food recently tends to fly to the patch in the morning with a characteristic flight, then other flocks at the roost which have failed to find a good patch of food on the previous day can join in and take advantage of the patch of food found by the first flock. This is a most attractive hypothesis and on its basis we expect communal roosters to be largely flock feeders. Our data confirms this in that flock feeders are certainly much better represented amongst communal roosters as compared to the non-communal roosters. However, communal roosters include a number of solitary feeders as well, notably the Common Pariah Kite and the White Scavenger Vulture. A more careful examination of the feeding habits of these would greatly help to clarify whether these birds do communicate information about the location of food sources in spite of the apparently solitary mode of feeding. Secondly, we may expect certain kinds of food sources to be much more patchy and temporary than others, e.g. fruit as opposed to rodents. An examination of the nature of food categories of communal roosters shows that invertebrates including insects and terrestrial vertebrates such as lizards and rodents are poorly represented in the diet of communal in comparison to non-communal roosters. It is certainly plausible that these food items are likely to be more widely dispersed and less likely to be temporary as compared to others such as fruit, though we need more detailed evidence before claiming that this strengthens our belief in communication of food locations as a function of communal roosting.

Lastly, communal roosts may serve an antipredatory function. Although communal roosts are likely to be at a disadvantage by being more conspicuous and therefore vulnerable, the advantage gained in receiving warning of the approach of predators from other members can be considerable and may outweigh the former disadvantage. Zahavi (1971) mentions that it was easy for his bird ringing group to catch by hand wagtails roosting solitarily, but very difficult to catch any from a communal roost. We would therefore expect communal roosting to be characteristic of those birds which (a) do not become much

more conspicuous than solitary roosters as a result of communal roosting and (b) which have a well developed system of warning signals. Condition (a) is probably fulfilled by birds of more open habitats, and (b) by birds which feed socially as well and therefore have developed a more elaborate warning system. Our data does show preponderance of birds of open habitats and flock-feeders amongst the communal roosters.

It is possible that smaller birds are more susceptible to predation and we should have expected a higher representation of them amongst communal roosters if avoidance of predation were a major function of communal roosting. However, as mentioned above, such bias is not very pronounced.

The phenomenon of mixed roosting strongly supports the notion of avoidance of predation being an important function of communal roosting (Gadgil 1972). There can hardly be communication of food location amongst birds of as different feeding habits as the House Crow and the Roseringed Parakeet. It is much more likely that both these species roost communally for predator avoidance and pool this advantage by forming mixed roosts of greater numerical strength. However, in certain other cases such as House Sparrow and Spanish Sparrow, the Weaver Birds and the Buntings, there may be communication of food location amongst different species as well. The whole problem of relations amongst different species at a mixed communal roost has yet to receive serious attention.

In conclusion, our data suggests that communication of information about the location of food sources and avoidance of predation are probably the two most significant functions of communal roosting.

Summary

At least the listed fifty-nine species of common Indian birds definitely form communal roosts in groups larger than feeding or migratory flocks without being forced to crowd together by a paucity of roosting sites. Thirty-five of these form communal roosts constantly throughout the year, another nine are migrants that roost communally during winter in India, and the rest of the species roost in a communal fashion only in the non-breeding season. Twenty species form small roosts of several individuals, twenty medium sized roosts of tens of individuals, nine large roosts with hundreds of individuals and ten enormous roosts of thousands of individuals of the given species. Twenty-six of these form mixed communal roosts of more than one species and birds of similar and dissimilar feeding habits are almost equally represented amongst the associates at a mixed communal roost. All of the

species that form roosts of thousands of individuals have some other species roosting in company with them. Birds of open habitats and birds which feed in flocks are represented to a much greater extent amongst communal roosters in comparison with the bird fauna as a whole, while birds which feed in pairs are represented very poorly. These features suggest that communication of information about food sources and reduction of the risk of predation are the two important functions of communal roosting.

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Contribution to the ferns of Annapurna-Dhaulagiri Range, Central Nepal[1]

V. D. VARTAK[2]

INTRODUCTION

The area of the holy Shrine at Muktinath dealt with in this work lies approximately between 27° 46′ to 28° 45′ N. latitudes and 83° 28′ to 84° 0′E longitudes. The terrain represents a cross section of the Himalayas from south to north.

The following table shows the sectors, localities and types of vegetation visited during the trek to Muktinath.

Sector	Broad forest types	Localities with altitude	Important peaks nearby
I. Tarai	Trop. evergreen	Butwal (300 m)	—
II. Siwalik Hills	Semi-evergreen	Ramdeghat (400 m)	—
	Moist deciduous	Putlikhet (660 m)	—
	Mixed deciduous	Walling (708 m)	—
III. Mahabharat Lekh		Pokhra (970 m)	Machapuchare range (7200 m)
		Navdanda (1020 m)	—
	Warm temperate Zone	Chandrakot (1720 m)	—
	Semi-evergreen Forest	Sudame (1800 m)	—
		Ualeri (2020 m)	—
		Baglung (about 1900 m)	—
		Kusuma (about 1500 m)	—
IV. Greater Himalayas Zone	Broad leaved	Deorali pass (3000 m)	—
	Alpine Forests	Tatopani (1210 m)	—
	Rhododendrons	Lete (2440 m)	Dhaulagiri Range (8500 m)
V. Inner Himalayas (Cold Temperate Zone)	Coniferous Forests	Tuknche (2550 m)	—
		Marpha (2618 m)	Annapurna Range (8400 m)
	Abies, Betula	Jomsom (2700 m)	
	Alpine shrubs	Kakbeni	—
VI. Tibetan plateau Sub-Arctic Zone	Caragana	Zarkot (3390 m)	Mansalu (8200 m)
	Ephedra	Muktinath (3500 m)	

[1] Accepted September 1971.

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The luxuriant magnificence of forests along Deorali-Ghodepani region (3500 m) is perhaps one of the best preserved natural vegetation areas in central Nepal. The Filicineae are abundant and all sorts of ferns and lycopods could be located. My only regret is that I could not get sufficient time for collection.

The present collection of Filicineae from the area under study is only 48 taxa of ferns confirmed and the remaining collection is still under study.

Identified families are arranged according to Copeland's GENERA FILICUM (1947) and the genera and species according to their alphabetic order. Under each species its locality, habitat, and approximate altitude, Herb. specimen number, the date of collection are given. Most of the species were confirmed by G. Panigrahi and are deposited at the Central Circle of the Botanical Survey of India, Allahabad. A second set of all the voucher specimens has been deposited and preserved at the M.A.C.S. Herbarium, Poona 4.

SCHIZAEACEAE

Lygodium japonicum Sw.

Hab. Open Forest near Lete, 2000 m *Vartak* 819 (28-5-68).

Lygodium flexuosum Sw.

Hab. Forest edge near Ramdeghat, 400 m *Vartak,* 395 (19-5-68).

GLEICHENIACEAE

Dicranopteris linearis Burm.

Hab. Road cutting near Putlikhet, 860 m *Vartak* 438 (21-5-68).

PTERIDACEAE

Adiantum capillus-veneris Linn.

Hab. Moist rocks, in wells and damp places. Putlikhet, 660 m *Vartak* 433 (21-5-68).

Adiantum incisum Forssk.

(*A. caudatum* Auct. non Linn.)

Hab. Open forest and along foot path near Ramdegad, 400 m *Vartak* 567 (20-5-68).

Adiantum philippense Linn.

(*A. lunulatum* Burm.)

Hab. In moist places. Pokhra, 970 m *Vartak* 461 (25-5-68).

Aleuritopteris farinosa Fee

(*Cheilanthes farinosa* Kaulf)

Hab. In Forest undergrowth near Kusuma, 1200 m *Vartak* 1021 (4-6-68).

Aleuritopteris albo-marginata (Cl.) Panigrahi

(*Cheilanthes albomarginata* Cl.).

In forest undergrowth near Ramdeghat, 400 m *Vartak* 386 (20-5-68).

Cheilanthes rufa Don

Hab. In rock crevices along foot path near Tatopani, 1210 m *Vartak* 762 (27-5-68).

Dennstaedtia appendiculata (Wall.) J. Sm.

Hab. Along stream banks between Lete, 2440 m and Marpha, 2610 m *Vartak* 879 (29-5-68).

Lindsaea cultrata Sw.

Hab. On moist vertical rocks along forest edge near Navdanda. *Vartak* 1079 (3-6-68).

Onychium auratum Kaulf

(*O. siliculosum* C. Chr.)

Hab. Along road-cuttings near Baglung, 1200 m *Vartak* 1029 (4-1-68).

Pityrogramma calomelanos Link.

(*Gymnogramme calomelanos* Kaulf)

Hab. In stream and among boulders near Kusuma, 1200 m *Vartak* 1025 (4-6-68).

Pteridium aquilinum (Linn.) Kuhn

(*Pteris aquilina* Linn.)

Hab. Open forest near Ramdeghat, 400 m *Vartak* 351 (19-5-68).

Pteris dactylina Hook.

Hab. Along the margin of the forests between Ghasa, 1920 m and Lete, 2550 m *Vartak* 805 (29-5-68).

Pteris cretica Linn.

Hab. In the undergrowth of the forests near Ghodepani, 3159 m *Vartak* 683 (26-5-68).

Pteris longispinula Wall.

Hab. Along foot path near Beni, 1100 m *Vartak* 1014 (3-6-68).

Pteris quadriaurita Retz.

Hab. In the undergrowth near Beni, 1100 m *Vartak* 1015 (3-6-68).

Pteris vittata Linn.

(*P. longifolia* Auct. non Linn.)

Hab. In rock crevices along road side near Ramdeghat, 400 m *Vartak* 457 (19-5-68).

Sphenomeris chusana (Linn.) Copel.

(*Stenoloma chinensis* Bedd.)

Hab. Along slopes of road-cutting near Ghodepani, 3150 m *Vartak* 737 (26-5-68).

Davalliaceae

Nephrolepis cordifolia (Linn.) Baker

Hab. In rock crevices along steep road-cuttings near Pokhra, 970 m *Vartak* 476 (22-6-68).

Oleandra wallichii Presl

Hab. In forest undergrowth near Ghodepani, 3150 m *Vartak* 679 (26-5-68).

Cyatheaceae

Cyathea spinulosa Wall.

Hab. Along stream banks between Berethati 1300 m to Sudame, 1800 m *Vartak* 601 (28-6-68).

Aspidiaceae

Athyrium esculentum Retz.

Anisogonium esculentum Presl)

Hab. In water-logged soil near Pokhra, 970 m *Vartak* 573 (22-5-68).

Cyclosorus parasiticus Farwell

(*Nephrodium molle* Desv.)

Hab. In water-logged fields and in undergrowth between Putlikhet 860 m and Pokhra, 970 m *Vartak* 476 (22-5-68).

Cyrtomium caryotileum Presl

Hab. Along road-cuttings between Ghasa, 1990 m and Lete, 2440 m *Vartak* 806 (28-6-68).

Dryopteris sparsa O. Ktze.

Hab. In forest undergrowth near Pokhra, 970 m *Vartak* 512 (23-5-68).

Elaphoglossum stigmatolepis (Fee) Moore

Hab. In undergrowth along foot-path near Ghodepani, 3150 m *Vartak* 678 (26-5-68).

Lastrea eriocarpa Dcne.

(*L. crenata* Bedd.)

Hab. In rock crevices along stream banks near Kusuma, 1200 m *Vartak* 1051 (4-6-68).

Polystichum aculeatum Sw. var. **rufo-barbatum** Wall.

Hab. In dense undergrowth near Sudame, 1800 m *Vartak* 630 (25-5-69).

Polystichum atkinsonii Bedd.

Hab. Among moss along hill cuttings, Ghodepani, 3150 m *Vartak* 662 (26-5-68).

Blechnaceae

Blechnum orientale Linn.

Hab. In open forests near Sudame on the way to Ulleri, 670 m *Vartak* 616 (25-5-68).

Woodwardia radicans Smith

Hab. Near stream banks along the edge of the forest near Ghodepani, 3150 m *Vartak* 728 (26-5-68).

Aspleniaceae

Asplenium aethiopicum Bech.

(*A. furcatum* Thunb.)

Hab. On branches in the evergreen forests of Ghodepani, 3150 m *Vartak* 1033 (26-5-68).

Asplenium dalhousiae Hook.

(*A. alternans* Wall.)

Hab. Along forest edge, Ramdeghat, 400 m *Vartak* 377 (19-5-68).

POLYPODIACEAE

Arthromeris wallichiana Ching
Hab. In thick undergrowth near Sudame, 1800 m *Vartak* 628 (25-5-68).

Drynaria propinqua J. Sm.
Hab. On tree trunks and branches in the evergreen forests of Ghodepani, 3150 m *Vartak* 896 (26-5-68).

Gonioplebium sub-auriculatum Presl
Hab. On tree trunks and branches. Putlikhet, 1100 m *Vartak* 444 (3-5-68).

Loxogramme involuta Presl
Hab. An epiphytic fern in evergreen forests of Ghodepani, 3150 m *Vartak* 677 (26-5-68).

Loxogramme scolopendrina Presl
Hab. An epiphytic fern found in open forests. Putlikhet, 1100 m *Vartak* 437 (21-5-68).

Microsorium lucidum Copel.
Hab. In undergrowth near Ghodepani, 3150 m *Vartak* 722 (26-5-68).

Pleopeltis loriformis Moore
Hab. An epiphytic fern in evergreen forests of Ghodepani, 3150 m *Vartak* (26-5-68).

Pleopeltis nuda Hook.
(*P. linearis* Bedd.)
Hab. In thick moss on moist rocks of the rapids near Chandrakot, 1720 m *Vartak* 592 (24-5-68).

Pyrrosia heteractis Ching
Hab. On tree trunks and horizontal branches. Putlikhet, 860 m. *Vartak* 437 (21-5-68).

Pyrrosia mannii Ching
Hab. On tree trunks and branches near Putlikhet, 1100 m *Vartak* 970 (22-5-68).

Pyrrosia nuda Ching
Hab. In fissures of exposed rocks among *Selaginella.* Ramdeghat, 400 m *Vartak* 485 (22-5-68).

VITTARIACEAE

Vittaria elongata Sw.
Hab. On tree branches. Kusuma, 2200 m *Vartak* 1037 (4-6-68).

Vittaria sikkimensis Kuhn
Hab. On tree branches near Chandrakot, 1720 m *Vartak* 581 (24-5-68).

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Systematic studies on fishes belonging to the Genus *Coilia* Gray, 1831[1]

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There has been considerable confusion in regard to the systematics of species of fishes of the genus *Coilia* commonly known as rat-tailed anchovies. Most of the confusion is due to the fact that adequate attention has not been paid to intraspecific variation in numbers of pectoral filaments, scutes and anal fin rays; the latter often misleading due to an artefact resulting out of caudal damage and subsequent regeneration. It is believed that, in all, four species occur in India.

Introduction

The fishes of the genus *Coilia,* commonly known as rat-tailed anchovies are of importance in the coastal fisheries at some places on the east coast of India. There has been considerable confusion in regard to the systematics of species of the genus. Fowler (1941) distinguished 14 species; 10 with maxilla not reaching beyond gill opening and 4 with maxilla reaching beyond gill opening. Most of the confusion existing in distinguishing the species is due to the fact that adequate attention has not been paid to intraspecific variation in number of pectoral filaments, scutes and anal fin rays; the latter often misleading due to an artefact resulting out of caudal damage and subsequent regeneration. The work of Whitehead (1966-1967) and Whitehead *et al.* (1966) has helped to remove the confusion in regard to the identification of most species. The key given by Whitehead (1967b) is particularly useful. The present contribution records and describes three species, *C. ramcarati* (Ham.-Buch., 1822), *C. korua* Dutt & Seshagiri Rao, 1972 and *C. dussumieri* Val. 1848 from Indian waters.

Materials and Methods

Fishes of the genus *Coilia* were obtained from shore seine catches near Gollapalem, Masulipatam (Krishna District) and Kakinada (east

[1] Accepted April 1974.

Godavari District) during 1966-70. In taking linear measurements total length was measured from tip of snout to longest caudal ray; standard length from tip of snout to mid-base of caudal fin; head length from tip of snout to hindmost point on operculum; depth is maximum depth.

Coilia Gray, 1831

Mystus Lacépede, 1803, *Hist. Nat. Poiss.*, 5:466 (Type: *Mystus clupeoides* Lacépede = *Clupea mystus* Linnaeus) (Pre-occupied by Gronow, 1763; Kliein, 1775; Scopoli, 1777).

Coilia Gray, 1830, *Illustr. Ind. Zool.*, *1*, pt. 1: pl. 85, fig. 3 (caption only); 1831, *Zool. Misc.*: 9 (Type: *Coilia hamiltoni* Gray = *Mystus ramcarati* Ham.—Buch.).

The genus *Coilia* includes Anchovies with their tail tapering to a point. Lacèpéde (1803) based his genus *Mystus* on a species of *Coilia*, but the name was pre-occupied elsewhere. *Coilia* Gray has been used for the rat-tailed anchovies for over a century. Jordan & Seale (1926) attempted to split the genus *Coilia* by creating a new genus *Demicoilia* for species with truncated caudal peduncles. But this condition of truncated caudal peduncle is due to its damage and subsequent regeneration. Bleeker's genus *Leptonurus* for species with light organs is also inadmissible as these light organs disappear beyond recognition during preservation in formalin as shown by Haneda (1961) and Dutt & Seshagiri Rao (1974).

Whitehead *et al.* (1966) and Whitehead (1967) have drawn attention to the need for revision of the genus.

The following key is useful in distinguishing the species.

I Pelvic rays i 8-9 *C. ramcarati* (Ham.-Buch., 1822)

II Pelvic rays i 6

- (A) Pectoral filaments 4-6
  - (i) Scutes 4-6 + 6-8. Pearly spots along flanks *C. dussumieri* Val., 1848
- (B) Pectoral filaments 10-14
  - (i) Scutes 4-6 + 8-9 *C. reynaldi* Val., 1848
  - (ii) Scutes 7-9 + 9-11 *C. korua* Dutt & Seshagiri Rao, 1972

The revised description of the species is as under:

Coilia ramcarati (Ham.-Buch., 1822)

Mystus ramcarati Hamilton-Buchanan, 1822, Fishes of Ganges: 233 (type locality: Ganges estuaries).

Coilia cantoris Bleeker, 1853, *Verh. Bat. Gen. 25*:148, pl. 6, fig. 2.

Coilia quadragesimalis Valenciennes, 1848, *Hist. Nat. Poiss. 21*:83.

Type: *Neotype*, a fish of 134.9 mm S.L. (147.0 mm tot. l.), *ex* Ganges, British Museum (Natural History), 1858.8.15.104 (designated type by Günther, 1868:403), described by Whitehead, 1967, *J. Mar. Biol. Ass. India*, *9*(1):31-33.

Material examined: 25 fishes, 142-219 mm S.L. (Gollapalem 11:12:66).

Description:

Br. St. 10-11, D I 12-14, P vi + 4-6, V i 8-9, A 90-100
g.r. 20-24 + 28-31, scutes 4-5 + 10-11.
In percentages of standard length: total length 108.2-112.2, body depth 18.0-20.2, head length 17.4-19.6; snout length 3.1-4.0, eye diameter 3.1-4.3, maxilla length 11.8-13.0; pectoral fin length (longest filament) 40.3-52.5, pelvic fin length 9.1-11.8; pre-dorsal distance 24.0-27.6, pre-pelvic distance 22.2-28.2, pre-anal distance 39.8-43.5.

Body compressed, depth nearly equal to head length, deepest below dorsal origin, tapering gradually from behind vent to tail. Belly somewhat rounded below pectoral origin and compressed from pelvic origin to vent. Abdominal serrae beginning well behind pectoral origin. Snout produced, equal to eye diameter. Lower jaw slender with a series of conical teeth and with prominent knob at dentary symphysis. Maxilla does not reach gill opening, extending beyond second supra-maxilla and tapering posteriorly. A single series of fine teeth along lower edge of maxilla. Two supra-maxillae, the anterior small and the posterior slender anteriorly and expanding posteriorly, the anterior portion being hidden behind the maxilla, when viewed from outer side.

Pseudobranch present, exposed nearly equal to eye diameter, with about 17-21 filaments. Gill rakers slender, twice length of corresponding gill filaments and equal to eye diameter.

Scutes sharply keeled, beginning midway between pectoral and pelvic bases.

Dorsal fin preceded by small scute-like spine. Distance from snout tip to dorsal origin four times in total length. Pectoral with 6 free filaments, the longest reaching between 29th and 32nd anal ray; longest branched ray not reaching pelvic base. Pelvic fin long, slightly less than postorbital length of head, its origin before dorsal origin, twice as close to pectoral base as to anal origin. Anal origin behind vertical from last dorsal ray by 2 eye diameters.

Colour: Dorsal side brownish descending on flanks above, flanks golden yellow. Unbranched dorsal rays dark, rest of fin pale yellow. Margin of anal and caudal dark. Pelvic pale, tip usually dark.

Note:

C. ramcarati can be easily distinguished from all other species of *Coilia* by high pelvic count (i 8-9, in all others i 6). Whitehead (1967) has shown that *C. quadragesimalis* is in fact *C. ramcarati*. Earlier, Jones & Menon (1952) pointed out that the description of *C. contoris* by Day (1889) strongly suggests a juvenile *C. ramcarati*. This was confirmed by Whitehead *et al.* (1966) after re-examination of the type material.

This species grows to a length of about 25 cm.

Coilia korua Dutt & Seshagiri Rao, 1972

Coilia korua Dutt & Seshagiri Rao, 1972, *J. Bombay nat. Hist. Soc.*, *69*(1): 136-138, Type locality, Gollapalem, Krishna District.

Material examined:

(a) 30 fishes, 100-116 mm S.L. Kakinada (9-5-70).

(b) 19 fishes, 90-118 mm S.L. Kakinada (5-11-70).

Description:

Br. St. 10-11, D I 12, P xii-xiii + 5-7, V i 5-6, A 101-106, g.r. 23-26 + 30-33, Scutes 7-9 + 9-11 (total 17-19).

In percentage of standard length: total length 109.1-111.6, body depth 20.0-20.9 head length 17.0-18.3; snout length 3.6-4.5, eye diameter 4.1-4.7, maxilla length 12.5-14.2; pectoral fin length (longest filament) 40.0-46.6, pelvic fin length 8.1-9.1; pre-dorsal distance 26.6-29.1, pre-pelvic distance 22.7-24.7, pre-anal distance 36.6-38.1.

Body compressed, depth slightly greater than head length, deepest below dorsal origin, tapering gradually to tail. Belly slightly convex, compressed and keeled from below pectoral origin to vent. Snout produced, equal to eye diameter. Lower jaw slender, with a series of small conical teeth and with prominent knob, at dentary symphysis. Maxilla does not reach gill opening; a series of fine teeth on premaxillae and along lower edge of maxillae. Two supra-maxillae, the anterior (first) delicate, nearly triangular and the posterior (second) slender anteriorly and expanding posteriorly, the anterior portion being hidden behind the maxilla, when viewed from outer side.

Pseudobranch present, exposed, equal to eye diameter, with about 10-14 filaments. Gill rakers slender, equal to eye diameter and twice length of corresponding gill filaments. Muscular portion of isthmus reaching forward to hind margin of branchiostegal membrane.

Scutes sharply keeled, beginning below pectoral origin.

Dorsal fin preceded by small scute-like spine. Distance from snout tip to dorsal origin less than four times in total length. Pectoral with 12-13 filaments, the longest reaching 23rd anal ray; longest branched ray reaching pelvic base. Pelvic length less than postorbital length of head; its origin before dorsal origin, nearer to pectoral base than to anal origin, equal to dorsal anal interspace (linear). Anal origin behind vertical from last dorsal ray by one eye diameter.

Colour: Dorsal side greenish, flanks golden yellow, abdomen and ventral side pale yellow. Fins hyaline, unbranched dorsal rays usually dark.

Note:

C. korua resembles *C. reynaldi*, *C. coomansi*, *C. polyfilis* and *C. borneensis* in pectoral filament number (12-14), but differs from all of them in the number of abdominal scutes (7-9 + 9-11; total 17-19) and

anal fin rays (101-106). Fowler (1941) mentions only 11 free pectoral rays in *C. polyfilis* for which there is no record besides the original description of Volz (1903) which is inadequate. The present species can be easily identified with the help of key given by Whitehead (1967), its place being between *C. reynaldi* and *C. coomansi*.

Coilia dussumieri Valenciennes, 1848

Coilia dussumieri Valenciennes, 1848, *Hist. Nat. Poiss., 21*:81, pl. 610, (type locality: Bombay, mahe, Pondicherry).

Leptonurus chrysostigma Bleeker, 1849, *Verh. Bat. Gen. 22*:14.

Demicoilia margaritifera Jordan and Seale, 1926, *Bull. Mus. Comp. Zool., 67*: 363.

Type: *Lectotype,* a fish of 155.4 mm S.L. (173.6 mm tot. 1.), *ex* Bombay, coll. Dussumier, Museum National d'Histoire Naturelle, Paris, 3749, (redescribed by Whitehead, 1967, *Bull. Br. Mus. Nat. Hist.* (Zool.) Suppl. 2. 154-55).

Material examined:

(a) 30 fishes, 120-156 mm S.L. Gollapalem (11-12-66)
(b) 10 fishes, 125-142 mm S.L. Gollapalem (26-11-67)
(c) 12 fishes, 120-130 mm S.L. Masulipatam (8-1-68)

Description:

Br. St. 9-11, D I 10-11, P v-vi + 8-11, V i 6, A 100-112,
g.r. 17-21 + 24-26, scutes 5-6 + 7-9.

In percentages of standard length: total length 108.6-111-7, body depth 18.7-21.7, head length 17.6-19.3 snout length 3.6-4.6, eye diameter 3.7-4.6, maxilla length 13.7-15.5; pectoral fin length (longest filament) 39.4-47.0, pelvic fin length 5.5-6.9; pre-dorsal distance 25.0-27.2, pre-pelvic distance 23.9-26.6, pre-anal distance 37.3-40.6.

Body compressed, depth nearly equal to head length, deepest below dorsal origin, tapering gradually to tail. Belly slightly convex, compressed from below pectoral origin to vent. Snout produced, equal to eye diameter. Lower jaw slender, with a series of small conical teeth and with prominent knob at dentary symphysis. Maxilla reaches gill opening, extending well beyond second supra-maxilla and tapering gradually. A single series of fine teeth along lower edge of maxilla. Two supra-maxillae, the anterior small, and the posterior slender anteriorly and expanding posteriorly, the anterior portion being hidden behind the maxilla, when viewed from outer side.

Pseudobranch present, exposed, small, less than eye diameter, about 9-11 short filaments. Gill rakers slender, twice length of longest gill filament.

Scutes sharply keeled, beginning behind pectoral origin.

Dorsal fin preceded by small scute-like spine. Distance from snout

tip to dorsal origin more than four times in total length. Pectoral with 5-6 free filaments, the longest reaching 35th anal ray or beyond; longest branched ray reaching pelvic base. Pelvic fin short, much less than post-orbital length of head, its origin below dorsal origin, slightly nearer pectoral base than anal origin. Anal origin below vertical from last dorsal ray by 2 eye diameters.

Colour: Dorsal side brownish, flanks yellowish with silvery reflections during life, becoming deep yellow on ventral side before anal. Posterior portion of anal and whole of caudal pigmented. A series of 20-28 pearly spots beginning slightly above base of pectoral, a second series of 23-30 spots beginning just behind pectoral base and extending posteriorly beyond first series. A third series of 6-10 spots beginning just behind gill opening on either side of isthmus. About four spots on either side of isthmus which are roughly in line with the third series. A row of 7 spots on either side of lower jaw ventrally. A patch of brownish dots on the snout.

Note:

C. dussumieri is the only species, so far known, with pearly spots (Luminous organs) on flanks. Jordan & Seale (1926) described *Demicoilia margaritifera* as having pearly spots on flanks and with a deep caudal peduncle. The description differs from that of *C. dussumieri* in two respects, shorter anal fin and deeper caudal peduncle. This may be the result of caudal damage and subsequent regeneration, which is most common among these fishes. *D. margaritifera* should also be referred to *C. dussumieri*. One specimen of *C. dussumieri* which shows an extreme case of caudal regeneration has been recorded.

Coilia reynaldi Valenciennes, 1848

Type: *Lectotype*, a fish of 97.0 mm S.L., 106.0 mm tot. l., *ex* Irrawady River, Rangoon, Museum National d'Histoire Naturelle, Paris. 3733, redescribed by Whitehead, 1967a, *Bull. Br. Mus. Nat. Hist*. (Zool.) Suppl. 2:150-152.

Whitehead (1967a) opined that *C. borneensis* is almost certainly a synonym of *C. reynaldi*. This species could not be collected from Andhra coast. *C. borneensis* is known to occur on Madras coast while *C. reynaldi* occurs in the Ganges estuary.

Coilia neglecta Whitehead, 1967

Coilia neglecta Whitehead, 1967, *J. Mar. biol. Ass. India, 9*(1):33-36 (type locality: Arabian sea).

Type: *Holotype*, a fish of 160.8 mm S.L., (175.0 mm tot. l.) *ex* Ara-

bian Sea deposited in the U.S. National Museum; *Paratypes*, 10 fishes, 141.5-169.5 mm S.L., British Museum (Natural History), 1967.11.20.560-569., Whitehead, 1967, *J. Mar. biol. Ass. India*, *9*(1):33-36.

C. neglecta resembles *C. dussumieri* in meristic and morphometric characters. The only difference being the absence of light organs on flanks in the former. These light organs disappear beyond recognition during preservation (Haneda 1961; Dutt & Seshagiri Rao 1974). Since the species was originally described basing solely on preserved material, it is a doubtful species until some stable characters are found to distinguish it from *C. dussumieri*.

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A contribution to the knowledge of Oriental Bruchidae[1]

T. G. Vazirani[2]

Introduction

The systematic studies of the family Bruchidae have been rather neglected in this country. The literature is scattered and the National Collections of the Zoological Survey of India, Calcutta, Indian Agricultural Research Institute, New Delhi and the Forest Research Institute, Dehra Dun, are rather poor in their respective holdings. Pic (1898-1938) has described a large number of species from India but barring a few species, all these are deposited either in the British Museum (Natural History), London or Museum D'Histoire Naturelle, Paris or other places.

Species of this family are known to do considerable damage to pulses, ground nuts, tamarind seeds and pods of various leguminous plants, in storage and in the field. Lefroy & Ghosh (1921) recorded 3 species, as being economically important in the storage of pulses and stated 'The pulse beetles have not yet been fully worked out. It is not known how many species of them, there are in all, in this country'.

The present checklist reveals the presence of at least 13 cosmopolitan species occurring in this country, in the total of 88 species that are listed here.

For the convenience of identification, a key to the subfamilies and genera has been provided.

One new name *Bruchidius nilue* has been proposed for *Bruchus stevensi* Pic (1938) a name which is preoccupied vide *Bruchus urbans* var. *stevensi* Pic, 1928. Twenty-three species have been assigned to their current genera and indicated as 'Comb. Nov.'. This assignment is mostly based on their published descriptions, many of which are however very poor to place all of them in the current genera; such species have been retained in original genera, till an opportunity arises to ex-

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amine 'Type' specimens or some other authentically determined material.

It is hoped that this contribution will stimulate taxonomic studies on this neglected though important group and encourage the use of current scientific names. Thomas (1967, Cyclostyled) in 'some Insect Pests found in Ware House and Sources of Infestation' mentions nine species but none of them has been referred to its current scientific name.

I am thankful to the head of the Entomology Division of Indian Agricultural Research Institute, New Delhi, to the Forest Entomologist, Forest Research Institute and College, Dehra Dun, and to the Head of Zoology Department, Punjab University for their kind help in supplying me the list of species in their respective collections, I am also thankful to Prof. Balachovsky, Director, Laboratoire, D'Entomologie, Museum National D'Histoire Naturelle, Paris, for kindly permitting me to examine some of the 'Type' specimens in Pic's Collections and for photostat copies of his various papers.

Species present in the collections of various institutions have been indicated below the distribution in the abbreviated form, I.A.R.I., F.R.I. & P.U. for Indian Agricultural Research Institute, Forest Research Institute & Punjab University respectively.

I am also thankful to Dr. A. P. Kapur, Director, Zoological Survey of India for his kind interest and the collections present in the department have been indicated by the abbreviation, 'Z.S.I.' I am also thankful to Dr. Ramdass Menon of the Indian Agricultural Research Institute, New Delhi for going through the paper and for very useful suggestions.

A. Key to the subfamilies of Bruchidae from Oriental Region

1. Hind tibiae with two mobile spurs; scutellum triangular; body almost rounded, scarcely longer than broad; eyes a little protruding; head not or only slightly constricted behind ... Subfam. (3) *Amblycerinae*
   Hind tibiae without mobile spurs at apex; scutellum quadrangular or indistinct; head usually with eyes protruding and constricted behind ... 2

2. Hind tibiae not or only slightly curved at base ... Subfam. (1) *Bruchinae*
   Hind tibiae strongly and evenly curved, the inner apical angle produced like a spur (hind femora strongly enlarged) ... Subfam. (2) *Pachymerinae*

B. Key to the genera of Subfamily Bruchinae known from the Oriental Region

1. Pronotum transverse; sides of pronotum with a small notch about the middle ... (1) *Bruchus*
   Pronotum conically narrowed anteriorly, sides straight or convex but without a lateral notch ... 2

2. Hind femora without any furrow at the lower margin, with or without a tooth at inner edge — 3
   Hind femora wholly or partly furrowed at lower margin — 4

3. Basal part of pronotum distinctly emarginate, longitudinally sulcate with two white pubescent tubercles at the middle of posterior margin — (3) *Callosobruchus*
   Basal part of pronotum not emarginate, without any white pubescent tubercles — (2) *Bruchidius*

4. Hind femora quite narrow — 5
   Hind femora strongly thickened — 6

5. Hind femora with a pointed tooth followed by two smaller teeth or tubercles on inner side — (5) *Acanthescelides*
   Hind femora not very strongly dentate — (6) *Conicobruchus*

6. Hind femora sharply ridged on each side of furrow/ sulcus but without any single prominent projection on it — *Sulcobruchus*[1]
   Hind femora with many teeth on the side of the furrow, first tooth strong followed by 2-4 denticles/serrations — (4) *Specularius*

C. Key to the genera of subfamily Pachymerinae known from the Oriental Region

1. Head elongate; eyes emarginate for half their length; elytra not covering the base of pygidium — (9) *Caryopemon*
   Head short; eyes emarginate for $\frac{1}{4}$th or less of its length and prominent; elytra covering the base of pygidium — 2

2. Pronotum with carinae and impressed lines complete; eyes distinctly emarginate but not exceeding $\frac{1}{4}$th of their length; tarsal joints 1 and 2 triangularly expanded (hind femora with large tooth near base, margin before it not serrate) — (7) *Pachymerus*
   Pronotum with carinae and impressed lines obsolete on the sides anteriorly; eyes hardly emarginate; tarsal joints 1 and 2 may be only little expanded at apex — (8) *Caryedon*

D. Key to the genera of subfamily Amblycerinae known from the Oriental Region

1. Anterior coxae quite contiguous at the tip; claws absolutely simple or minute but not lobed at base — (11) *Zabrotes*
   Anterior coxae more or less separated; claws distinctly — (10) *Spermophagus*

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[1] Likely to occur in India.

Family BRUCHIDAE
Subfamily Bruchinae
Genus 1. *Bruchus* Linnaeus
Type species—*Bruchus pisorum* (Linnaeus)

1. **Bruchus affinis** Frolich

Bruchus affinis Frolich, 1799, *Naturforsches,* 28:55. Allard, 1895, *Bull. Soc. ent. Belg., 39*:225. Pic, 1913, *Coleopt. Cat., 26*:13. Fletcher & Ghosh, 1921, *Proc. 3rd. ent. meeting Pusa, 2*:721. Hoffmann, 1945, *Fn. France, 44*:44. Luk Yanovika & Ter Minasyan, 1957, *Fn. USSR,* Coleoptera: Bruchidae, 24 (1): 98. Shomar, 1964, *Bull. Soc. ent. Egypte, 47*:144.
Bruchus flavimanus Boheman, 1833, in Schonherr, *Genera et Species Curculionidum, 1*:59.
Bruchus obscuritaris Motschulsky, 1874, *Bull. Soc. Imp. Nat. Moscou, 39*:244 (1873).
Bruchus ruthenicus Beker, 1892, *Bull. Soc. Imp. Nat. Moscou,* 1892:69.
Bruchus monticola Bedel, 1901, *Fauna des Coleopteres du bassin de la Seine,* 5:348.
Hosts—*Pisus arvense,* (Peas of all kinds).
Distribution—Cosmopolitan.
I.A.R.I., F.R.I.

2. **Bruchus bilineatopygus** Pic

Bruchus bilneatopygus Pic, 1938, *Ann. Mag. nat. Hist.,* (11)*2*:399, (Dehra Dun—Holotype in Brit. Mus. and paratypes in Pic coll., Paris Mus.).
Distribution—India.
F.R.I.

3. **Bruchus caerulens** Champion

Bruchus caerulens Champion, 1919, *Ent. Mon. Mag., 55*:244.
Distribution—India.

4. **Bruchus diversicolor** Pic

Bruchus diversicolor Pic, 1913, *Echange,* 1913:110 (nom. nov.). Pic, 1913, *Coleopt. Cat., 26*:24.
Bruchus versicolor Motschulsky, 1874, *Bull. Soc. Imp. Nat. Moscou, 39*:244 (India or.—name preoccupied).
Distribution—?India.

5. **Bruchus dolichosi** Gyllenhal

Bruchus dolichosi Gyllenhal, in Schonherr, 1839, *Genera et Species Curculionidum, 5*:5 (Nepal). Pic, 1913, *Coleopt. Cat., 26*:24.
Distribution—Nepal.

6. **Bruchus dorsalis** Fahrreus

Bruchus dorsalis Fahrreus, in Schonherr, 1833, *Genera et Species Curculionidum, 1*:98 (India, Bengal). Heyden, 1879, *Deutsche Ent. Zeit., 23*:357. Roelofe, 1880, *Ann. Soc. ent. Belg., 24*:30. Schilsky, 1905, *Die Kafer Euro-*

pas, 41 no. 93. Pic, 1913, *Coleopt. Cat., 26*:24.
Distribution—India, Japan, China.

7. **Bruchus griseosuturalis** Pic

Bruchus griseosuturalis Pic, v932, *Ann. Mag. nat. Hist. Lond.,* (10)*9*:331, (Coorg: Fraserpet—Brit. Mus.).
Distribution—India.

8. **Bruchus incretus** Walker

Bruchus incretus Walker, 1859, *Ann. Mag. nat. Hist. Lond.,* (3)*3*:261. (Ceylon —Brit. Mus.).
Distribution—Sri Lanka.

9. **Bruchus indigoferrae** Gyllenhal

Bruchus indigoferrae Gyllenhal, 1833, in Schonherr, *Genera et Species Curculionidum,* 1:34 (India Orientalis). Allard, 1895, *Ann. Soc. ent. Belg., 39*:226 (Belgaum). Pic, 1913, *Coleopt. Cat., 26*:29.
Host—*Indigofera tinctoria.*
Distribution—India.
F.R.I.

10. **Bruchus kashmiricus** Pic

Bruchus kashmiricus Pic, 1929, *Echange, 45*:4 (Kashmir—Paris Mus.).
Distribution—India.

11. **Bruchus lineolatus** Motschulsky

Bruchus lineolatus Motschulsky, 1874, *Bull. Soc. Imp. Nat. Moscou, 46*:225 (India Or.). Pic, 1913, *Coleopt. Cat., 26*:31.
Distribution—India.

12. **Bruchus matheroni** Pic

Bruchus matheroni Pic, 1913, *Melonges exotico-entomologiques, 6*:14 (Maharashtra: Bombay: Matheran).
Distribution—India.

13. **Bruchus maculothorax** Pic

Bruchus maculothorax Pic, 1928, *Ann. Mag. nat. Hist. Lond.,* (10)*1*:298. (U.P.: Gonda, Janakpur—Paris Mus.). Mukerji & Chatterji, 1951, *Indian J. ent., 13*:14, pl. iv, fig. 7 (genitalia).
Host—*Dalbergia paniculata* (seeds).
Distribution—India.
I.A.R.I.

14. **Bruchus mendosus** Gyllenhal

Bruchus mendosus Gyllenhal, in Schonherr, 1839, *Genera et Species Curculionidum, 5*:72 (Bengal). Fahrreus, *Ofv. Vet. Akad. Forh,* 1871:449. Allard, 1895, *Ann. Soc. ent. Belg., 39*:225 (Kanara, Belgaum.). Pic, 1923, *Coleopt.*

Cat., *26*:35. Mukerji and Chatterji, 1951, *Indian J. ent.*, *13*:13-14, pl. iv, figs. 3-6 (genitalia).
Distribution—India.
I.A.R.I., F.R.I.

15. **Bruchus minimus** Motschulsky

Bruchus minimus Motschulsky, 1858, *Etudes Entomologiques*, *7*:97 (Burma). Motschulsky, 1874, *Bull. Soc. Imp. Nat. Moscou*, *46*:217 (Key to spp.). Pic, 1913, *Coleopt. Cat.*, *26*:35 (Burma, India).
Distribution—Burma, India.

16. **Bruchus nigripennis** Allard

Bruchus nigripennis Allard, 1895, *Ann. Soc. ent. Belg.*, *39*:226 (Himachal Pradesh: Chamba). Pic, 1913, *Coleopt. Cat.*, *26*:37.
Distribution—India.

17. **Bruchus nigrosinuatus** Allibart

Bruchus nigrosinuatus Allibart, 1847, *Rev. Zoologique*, 1847:16 (India). Allard, 1895, *Ann. Soc. ent. Belg.*, *39*:226 (Belgaum). Pic, 1913, *Coleopt. Cat.*, *26*: 37.
Distribution—India.

18. **Bruchus pisorum** (Linnaeus)

Dermestes pisorum Linnaeus, 1758, *Systema naturae, ed.* 10:356 (America).
Bruchus pisorum Pic, 1913, *Coleopt. Cat.*, *26*:41. Hoffmann, 1945, *Fn. France*, *44*:118. Mukerji & Chatterji, 1951, *Indian J. ent.*, *13*:9, pl. ii, fig. 5 (genitalia). Luk Yanovika & Ter Minasyan, 1957, *Fn. USSR.* Col. Bruchidae, *24*:93, fig. 81-82. Shomar, 1964, *Bull. Soc. ent. Egypte*, *47*:148.
Bruchus salicis Scopoli, 1763, *Entomologia Carnilica*, Vindobonae, 1763:22.
Bruchus pisi Linnaeus, 1767, *Systema naturae, ed.* 12, 1:604.
Bruchus crucifer Geoffroy, 1785, in Fourcroy, *Entomologia Parisiensis Catalogue Insectorum*, *1*:112.
Bruchus salicis var. *sparsus* Fabricius, 1801, *Systema Eleutheratorum*, *2*:398.
Bruchus salicis var. *intermedius* Motschulsky, 1854, *Etudes Entomologiques*, *5*: 16.
Bruchus lunaris Rey, 1893, *Echange*, *9*:3.
Bruchus lunaris var. *unifasciatus* Rey, 1893, Echange, *9*:3.
Hosts—*Vicia* spp.; *Cassia fistula* Linn., *Pisum sativum* Linn.
Distribution—Cosmopolitan.
I.A.R.I., P.U., F.R.I.

19. **Bruchus ochreatus** Motschulsky

Bruchus ochreatus Motschulsky, 1874, *Bull. Soc. Imp. Nat. Moscou*, *46*:210 (India Or.). Pic, 1913, *Coleopt. Cat.*, *26*:38.
Distribution—India.

20. **Bruchus pruinius** Horn

Bruchus pruinius Horn, 1873, *Trans. Amer. ent. Soc.*, *4*:324 (Mexico). Sharp,

1885, *Biol. Centr. Amer. Col.*, *5*:453. Pic, 1913, *Coleopt. Cat.*, *26*:38.
Distribution—India.

21. **Bruchus schroderi** Pic

Bruchus schroderi Pic, 1930, *Echange.*, *46*:6 (Germany).
Distribution—Germany, India.
F.R.I.

22. **Bruchus sparsmaculatus** Pic

Bruchus sparsmaculatus Pic, 1913, *Echange,* 1913:144.
Distribution—India.
F.R.I.

23. **Bruchus trifasciatus** Motschulsky

Bruchus trifasciatus Motschulsky, 1866, *Bull. Soc. Imp. Nat. Moscou, 39*:405 (Ceylon). Pic, 1913, *Coleopt. Cat.,* 26:53.
Distribution—India.

24. **Bruchus walkeri** Pic

Bruchus walkeri Pic, 1912, *Echange, 28*:92 (nom. nov.); Pic, 1913, *Coleopt. Cat., 26*:57.
Bruchus figuratus Walker, 1859, *Ann. Mag. nat. Hist. Lond.*, (3)*3*:261 (Ceylon) nec Gyllenhal, 1839:12.
Distribution—Ceylon.
F.R.I.

Genus 2. *Bruchidius* Schilsky (1905)
Type species—*Bruchidius quinqueguttatus* (Olivier)

25. **Bruchidius andrewesi** (Pic)

Bruchus andrewesi Pic, 1932, *Ann. Mag. nat. Hist.,* (10)*9*:330. (Annamalais—Brit. Mus. & Paris Mus.).
Bruchidius andrewesi, Mukerji & Chatterji, 1951, *Indian J. ent., 13*:14, pl. v, figs. 1-3 (genitalia).
Host—*Acacia leucophloea*
Distribution—India.
I.A.R.I.; P.U.; F.R.I.

26. **Bruchidius angustifrons** Schilsky

Bruchidius angustifrons Schilsky, 1905, Die Kafer Europas; *41*:52 (Egypt). Shomar, 1964, *Bull. Soc. ent. Egypte, 47*:160-161, figs. 55, 67.
Bruchus angustifrons, Pic, 1913, *Coleopt. Cat., 26*:15.
Distribution—Egypt, India.

27. **Bruchidius cinereovarius** (Motschulsky) Comb. Nov.

Bruchus cinereovarius Motschulsky, 1874, *Bull. Soc. Imp. Nat. Moscou, 46*: 224 (1973) (India Or.).

Distribution—? India.

28. **Bruchidius costulatus** (Pic), Comb. Nov.

Bruchus costulatus Pic, 1932, *Ann. Mag. nat. Hist. Lond.,* (10)*9*:330 (Coorg: Fraserpet—Brit. Mus.).
Distribution—India.

29. **Bruchidius decretus** (Walker) Comb. Nov.

Bruchus decretus Walker, 1859, *Ann. Mag. nat. Hist. Lond.,* (3)*3*:261 (Ceylon —Brit. Mus.). Allard, 1895, *Ann. Soc. ent. Belg., 39*:227. Pic, 1913, *Coleopt. Cat., 26*:23.
Distribution—India, Ceylon.

30. **Bruchidius dilataticornis** (Pic) Comb. Nov.

Bruchus dilataticornis Pic, 1928, *Bull. Soc. ent. Fr.,* 1928:315 (Nilgiri hills—Brit. Mus.).
Distribution—India.

31. **Bruchidius gardneri** (Pic) Comb. Nov.

Bruchus gardneri Pic, 1938, *Ann. Mag. nat. Hist. Lond.,* (11)*2*:400 (Dehra Dun —Holotype in Brit. Mus. & Paratypes in Paris Mus.).
Distribution—India.
F.R.I.

32. **Bruchidius kashmirensis** (Pic) Comb. Nov.

Bruchus biguttatus Blanchard, 1844, *Ann. Soc. ent. Fr.,* (Bull.). (2)*2*:27 nec Olivier, 1795. (Kashmir).
Bruchus kashmirensis Pic, 1912, *Echange, 28*:92 (nom. nov.). Pic, 1913, *Coleopt. Cat., 26*:17.
Distribution—India.

33. **Bruchidius latior** (Pic) Comb. Nov.

Bruchus latior Pic, 1932, *Ann. Mag. nat. Hist.,* (10)*9*:330 (Barany—Brit. Mus.).
Distribution—India.

34. **Bruchidius maculipyga** (Champion) Comb. Nov.

Bruchus maculipyga Champion, 1931, *Ent. Mon. Mag., 55*:245. Mukerji & Chatterji, 1951, *Indian J. ent. 13*:11, pl. 111, figs. 10-13 (genitalia).
Host—Pods of *Acacia pennanta.*
Distribution—India.
P.U.; F.R.I.

35. **Bruchidius minutisimus** (Motschulsky) Comb. Nov.

Bruchus minutisimus Motschulsky, 1858, *Etudes Entomologiques, 7*:98 (Agra). Motschulsky, 1874, *Bull. Soc. Imp. Nat. Moscou, 46*:215 (1873). Allard, 1895, *Ann. Soc. ent. Belg., 39*:227. Pic, 1913, *Coleopt. Cat., 26*:35. Mathur and Singh, 1959, *Indian For. Bull. 171*(4):29.

Host—Seeds of *Desodium triquetrum.*
Distribution—India.
I.A.R.I.; F.R.I.

36. **Bruchidius minutus** (Fabricius) Comb. Nov.

Bruchus minutus Fabricius, 1801, *Syst. Eleutheratorum,* 2:401. Gyllenhal, in Schonherr, 1839, *Genera et Species Curculionidum,* 5:56. Pic, 1913, *Coleopt. Cat.,* *26*:35 (Central & S. America).
Pachybruchus minutus Sharp, 1885, *Biol. Centr. Amer. Col.,* 5:487.
Distribution—Cosmopolitan.
P.U.

37. **Bruchidius nalandus** (Pic) Comb. Nov.

Bruchus nalandus Pic, 1927, *Mel. exot. ent.,* *48*:12 (Ceylon). Mathur & Singh, 1959, *Indian For. Bull.,* *171*(4):28.
Host—*Desodium pulchellum.*
Distribution—Ceylon.
F.R.I.

38. **Bruchidius ocularis** (Pic) Comb. Nov.

Bruchus ocularis Pic, 1932, *Ann. Mag. nat. Hist.,* (10)*9*:331 (Madras: Salem; Jawalagiri—Paris Mus.).
Distribution—India.

39. **Bruchidius pauper** (Bohemann) Comb. Nov.

Bruchus pauper Bohemann, 1829, *Nouv. Mem. Soc. Nat. Moscou,* *1*:115. Allard, 1868, *Ann. Soc. ent. Belg.,* *11*:99. Pic, 1913, *Coleopt. Cat.,* *26*:40.
Distribution—Central & South Europe, Morocco, Algiers, Corsica, India.

40. **Bruchidius rufiventris** (Allard) Comb. Nov.

Bruchus rufiventris Allard, 1895, *Ann. Soc. ent. Belg.,* *39*:227 (Belgaum). Pic, 1913, *Coleopt. Cat.,* *26*:46.
Distribution—India.

41. **Bruchidius sahlbergi** Schilsky

Bruchidius sahlbergi Schilsky, 1905, *Kaf. Eur.,* *41*:nr. 94 (Egypt). Shomar, 1964, *Bull. Soc. ent. Egypte,* *47*:173, figs. 92-107.
Bruchus sahlbergi, Pic, 1913, *Coleopt. Cat.,* *26*:47.
Distribution—Egypt, India.

42. **Bruchidius sandali** (Pic) Comb. Nov.

Bruchus sandali Pic, 1932, *Ann. Mag. nat. Hist.,* (10)*9*:331 (Coorg: Fraserpet —Brit. Mus.).
Host—Sandalwood.
Distribution—India.

43. **Bruchidius nilue** nom. nov.

Bruchus stevensi Pic, 1938, *Ann. Mag. nat. Hist.*, (11)*2*:400 (Kurseong—Paris Mus.). Name preoccupied vide Pic, 1928:315.
Distribution—India.

44. **Bruchidius saundersi** (Jekel)

Bruchus saundersi Jekel, 1855, *Ins. Saunders, 1*:6, t. 1, f. 1. Pic, 1913, *Coleopt. Cat., 26*:47.
Bruchus cheveroleti Allard, 1868, *Ann. Soc. ent. Belg., 11*:93, 108.
Bruchidius saundersi, Shomar, 1964, *Bull. Soc. ent. Egypte, 47*:174.
Distribution—Egypt, India.
P.U.; F.R.I.

45. **Bruchidius vectabilis** (Gyllenhal) Comb. Nov.

Bruchus vectabilis Gyllenhal, in Schonherr, 1839, *Genera et Species Curculionidum, 5*:100 (Bengal). Allard, 1895, *Ann. Soc. ent. Belg., 39*:227. (Belgaum). Pic, 1913, *Coleopt. Cat., 26*:55. Mukerji & Chatterji, 1951, *Indian J. ent., 13*:10, pl. iii, figs. 1-3, (genitalia). Mathur & Singh, 1960, *Indian For. Bull., 171*(8) :34.
Host—*Sesbania aculeata;* Rose flowers.
Distribution—India.
I.A.R.I; F.R.I.

46. **Bruchidius uberatus** (Fahrreus) Comb. Nov.

Bruchus uberatus Fahrreus, 1839, in Schonherr, *Genera et Species Curculionidum, 5*:40. (Africa: Bahr-et-Abiad). Allard, 1895, *Ann. Soc. ent. Belg., 39*:227 (Belgaum). Pic, 1913. *Coleopt. Cat., 26*:53. Mukerji & Chatterji, 1951, *Indian J. ent., 13*:13, pl. iv, figs. 1-2. Mathur & Singh, 1959, *Indian For. Bull., 171*(4) :8, 59.
Hosts—*Dalbergia paniculata; Prosopis julifera; Albizzia stipulata; Albizzia odoratissima; Arbus precatorius, Acacia modesta.*
Distribution—India, Africa.
I.A.R.I.; F.R.I.

47. **Bruchidius urbans stevensi** (Pic) Comb. Nov.

Bruchus urbans var. *stevensi* Pic, 1928, *Bull. Soc. ent. Fr.*, 1928:315. (Sikkim: Gopaldara—Brit. Mus.).
Distribution—India.
P.U.; F.R.I.

Genus 3. *Callosobruchus* Pic (1902).
Type species—*Callosobruchus chinensis* (Linnaeus)

48. **Callosobruchus albocallosus** (Pic)

Bruchus (*Callosobruchus*) *albocallosus* Pic, 1927, *Mel. Exot. ent., 48*:12 (Indes Merdionales). Pic, 1932, *Ann. Mag. nat. Hist.*, (10)*9*:329.
Distribution—India.
F.R.I.

49. **Callosobruchus analis** (Fabricius)

Bruchus analis Fabricius, 1781, Species *Insectorum......1*:75 (India Orientalis —Brit. Mus.). Fabricius, 1787, *Mantissa Insectorum......1*:42. Fabricius, 1788, *Systema naturae, 1*(4):1735. Olivier, 1790, *Encyclopedie methodique, 5*:200. Fabricius, 1792, *Entomologia Systematica, 1*:371. Fabricius, 1801, *Systema Eleutheratorum, 2*:398. Schonherr, 1833, *Genera et Species Curculionidum, 1*:41. Pic, 1913, *Coleopt. Cat., 26*:15. Mukerji & Chatterji, 1951, *Indian J. ent., 13*:8, pl. ii, figs. 1-3 (genitalia).

Callobruchus analis: Southgate, Howe et Brett, 1957, *Bull. ent. Res., 48*:79.

Bruchus jekeli Allibart, 1847, *Rev. Zoologique,* 1847:15 (China). Allard, 1895, *Ann. Soc. ent. Belg., 39*:226 (Kanara).

Bruchus glaber Allibart, 1847, *Rev. Zoologique,* 1847:16 (China).

Host—*Vigna catang,* also pulses like Mung, Urd, and redgram.

Distribution—China, India.

I.A.R.I.; P.U.; F.R.I. (also under name *B. glaber* Allibart).

50. **Callosobruchus chinensis** (Linnaeus)

Curculio chinensis Linnaeus, 1758, *Systema naturae,* ed. 10, *1*:386 (China).

Bruchus chinensis: Schonherr, 1833, *Genera et Species Curculionidum, 1*:101. Allard, 1895, *Ann. Soc. ent. Belg., 39*:226 (Belgaum). Feltcher & Ghosh, 1921, *Proc. 3rd. ent. Meeting Pusa,* 721, pl. 107, fig. 1. (Life history). Mukerji & Bhuya, 1937, *J. Morph., 61*:175.

Callosobruchus chinensis: Mukerji & Chatterji, 1951, *Indian J. Ent., 13*:14, pl. 14. figs. 8-11. Luk Yanovika & Ter Minasyan, 1957, Fn. USSR, Coleoptera: Bruchidae, *24*(1):67, fig. 40. Southgate, 1958, *Bull. ent. Res., 49*(3):591. Shomar, 1964, *Bull. Soc. Ent. Egypte, 47*:180, figs. 132-143.

Bruchus pectinicorus Linnaeus 1767, *Systema naturae,* ed. 10, *1*:605.

Bruchus rufus Degeer, 1775, *Mem. Ins., 5*:281, f. 7.

Bruchus scutellaris Fabricius, 1792, *Entomologia Systematica, 1*:372.

Bruchus bistriatus Fabricius, 1801, *Systema Eleutheratorum,* 2:402.

Bruchus barbicornis Fabricius, 1801, *Systema Eleutheratorum, 2*:403.

Bruchus elegans Sturm, 1826, *Cat. meiner Insecten,* Samlung, 1826:103.

Bruchus adustus Motschulsky, 1874, *Bull. Soc. Imp. Nat. Moscou, 46*:227 (1873)

Hosts—Various kinds of pulses, beans, peas etc.

Distribution—Cosmopolitan.

Z.S.I.; I.A.R.I.; P.U.; F.R.I.

51. **Callosobruchus madurensis** Pic

Bruchus (*Callosobruchus*) *madurensis* Pic, 1927, *Mel. exot. ent., 48*:12 (India).

Distribution—India.

52. **Callosobruchus maculatus** (Fabricius)

Bruchus maculatus Fabricius, 1775, *Systema Entomologie*: 65 (America—Univ. Zool. Mus., Copenhagen).

Callosobruchus maculatus, Pic, 1913, *Coleopt. Cat., 26*:33. Hoffmann, 1945, Fn. France, *44*:89. Southgate, Howe & Brett, 1957, *Bull. ent. Res., 48*:79. Luk Yanovika & Ter Minasyan, 1957, *Fn. USSR,* Coleoptera, Bruchidae, *24*(1): 68. Shomar, 1964, *Bull. Soc. ent. Egypte, 47*:182. Arora, Pajni & Singh 1968, *Res. Bull. Punj. Univ., 18*:501 (abnormal male).

Bruchus quadrimaculatus Fabricius, 1792, *Entomologia Systematica, 1*:371

(America—Univ. Zool. Mus. Copenhagen). Mukerji & Hakim Bhuya, 1937, *J. Morph.*, *61*:175 (reproductive system).

Bruchus ornatus Bohemann, 1829, *Nouv. Mem. Soc. Nat. Moscou*, *1*:103. Pic, 1913, *Coleopt. Cat.*, *26*:39.

Bruchus vicinus Gyllenhal, in Schonherr, 1833, *Genera et Species Curculionidum*, *1*:36. Pic. 1913, *Coleopt. Cat.*, *26*:36.

Bruchus ambiguus Gyllenhal, in Schonherr, 1833 *Genera et Species Curcilionidum*, *1*:11, Pic, 1913, *Coleopt. Cat.*, *26*:14.

Bruchus ambiguus Gyllenhal, in Schonherr, 1833 *Genera et Species Curculionidum*, *5*:8. Pic, 1913, *Coleopt. Cat.*, *26*:50.

Hosts—Various kinds of pulses, beans etc.

Distribution—Cosmopolitan.

P.U.; F.R.I.

53. **Callosobruchus nigripennis** Allard

Callosobruchus nigripennis Allard, 1895, *Ann. Soc. ent. Belg.*, *39*:226 (Chamba).

Bruchus nigripennis: Pic, 1913, *Coleopt. Cat.*, *26*:37.

Distribution—India.

F.R.I.

54. **Callosobruchus phaseoli** (Gyllenhal)

Bruchus phaseoli Gyllenhal, in Schonherr, 1833, *Genera et Species Curculionidum*, *1*:37 (Brazil). Pic, 1913, *Coleopt. Cat.*, *26*:40. Mukerji & Chatterji, 1951, *Indian J. ent.*, *13*:8, pl. i, figs. 5-8. (genitalia).

Callosobruchus phaseoli: Luk Yanovika & Ter Minasyan, 1957, *Fn. USSR*, Coleoptera, Bruchidae, *24*(1):68.

Hosts—*Dolichos lablab.*

Distribution—Brazil, Italy, Europe, Southern U.S.S.R., India.

I.A.R.I.; F.R.I.

55. **Callosobruchus theobromae** (Linnaeus)

Bruchus theobromae Linnaeus, 1767, *Systema naturae*, ed. 12, *1*:605 (India Orientalis). Fabricius, 1775, *Systema Entomologie*, 65. Linnaeus, 1788, *Systema naturae*, ed. Gmelin, *1*(4):1735. Fabricius, 1792, *Entomologia Systematica*, *1*:371. Schonherr, 1833, *Genera et Species Curculionidum*, *1*: 41.

Bruchus theobromae: Allard, 1895, *Ann. Soc. ent. Belg.*, *39*:226 (Belgaum). Pic, 1913, *Coleopt. Cat.*, *26*:52. Mukerji & Chatterji, 1951, *Indian J. Ent.*, *13*:6.

Hosts—Theobromae feminibus, Cajanus indicus.

Distribution—India.

I.A.R.I.; P.U.; F.R.I.

Genus 4. *Specularius* Bridwell (1938)

Type species—*S. erithrinae* Bridwell 1938

S. impressithorax Pic as modified by Declle (1951).

56. **Specularius maindroni** (Pic) Comb. Nov.

Bruchus (*Callosobruchus*) *maindroni* Pic, 1914, *Mel. exot. ent.*, *11*:6 (Indes).

Distribution—India.

Genus 5. *Acanthoscelides* Schilsky (1905)
Type species—*Acanthoscelides obtectus* (Say)

57. **Acanthoscelides centromaculatus** (Allard)

Bruchus centromaculatus Allard, 1868, *Ann. Soc. ent. Belg., 11*:93, 107. Pic, 1913, *Coleopt. Cat., 26*:20.
Acanthoscelides centromaculatus: Shomar, 1964, *Bull. Soc. ent. Egypte, 47*:185.
Distribution—Egypt, Mexico, Central America, Cuba, India.
F.R.I.

58. **Acanthoscelides obtectus** (Say)

Bruchus obtectus Say, 1831, *Desc. Curc. N. America,* p. 1. Mathur & Singh, 1959, *Bull. Indian For., 171*(3):15.
Acanthoscelides obtectus: Luk Yanovika & Ter Minosyan, *Fn. USSR.,* Coleoptera, Bruchidae, *24*(1):172.
Bruchus obsoletus Say, 1831, *Desc. Curc. N. America,* p. 2. Pic, 1913, *Coleopt. Cat., 26*:37. Hoffmann, *Fn. France, 44*:90. Shomar, 1964, *Bull. Soc. ent. Egypte, 47*:185.
Bruchus breweri Crotch, 1867, *Proc. zool. Soc. Lond.,* 1867:389.
Distribution—Cosmopolitan.

Genus 6. *Conicobruchus* Decelle (1951)
Type species—*Conicobruchus strangulatus* (Fahrreus)

59. **Conicobruchus albopubens** (Pic) Comb. Nov.

Bruchus albopubens Pic, 1931, *Melan. exot. ent., 57*:26.
Distribution—India.
P.U.

60. **Conicobruchus indicus** (Pic) Comb. Nov.

Bruchus indicus Pic, 1909, *Echange, 25*:118. (India—Paris Mus.).
Bruchus indicus var. *acanthidis* Pic, 1909, *Echange, 25*:118 (India—Paris Mus.).
Distribution—India.
I.A.R.I.; P.U.

Subfamily: Pachymerinae

Genus 7. *Pachymerus* Thunberg (1805)
Type species—*Pachymerus bactris* (Olivier)

61. **Pachymerus ceylonicus** Pic

Pachymerus ceylonicus Pic, 1924, *L'Echange Revue Linnenne, 5*:25 (Ceylon).
Distribution—Sri Lanka.

62. **Pachymerus indus** (Motschulsky)

Caryoborus indus Motschulsky, 1858, *Etudes Entomologiques, 7*:98. (India Or.). Schaufuss, 1882, *Ann. Soc. ent. Fr.,* (6)2:85. (Type in Mus. Ludwid Salvator, Geneva).
Pachymerus indus Pic, 1913, *Coleopt. Cat. 26*:7.

Distribution—India.
F.R.I.

63. **Pachymerus lineaticollis** Pic

Pachymerus lineaticollis Pic, 1906, *Bull. Soc. ent. Fr.*, 1906:58 (Cochin-China). Pic, 1913, *Coleopt. Cat.*, *26*:8.
Distribution—Indochina, India.
F.R.I.

64. **Pachymerus notativentris** Pic

Pachymerus notativentris Pic, 1924, *Mel. exot. ent.*, *42*:24 (India).
Distribution—India.

Genus 8. *Caryedon* Schonherr (1826)
Type species—*Caryedon gonagra* (Fabricius)

65. **Caryedon acaciae** (Gyllenhal) Comb. Nov.

Pachymerus acaciae Gyllenhal, in Schonherr, 1833, *Genera et Species Curculionidum, 1*:97. Hoffmann, 1945, *Fn., France, 44*:95. Shomar, 1964, *Bull. Soc. ent. Egypte, 47*:189, figs. 163-176.
Distribution—India, Egypt.
P.U.

66. **Caryedon gonagra** (Fabricius)

Caryoborus gonagra Fabricius, 1798, *Entomologia systematica, supplement*, 1798:159 (India). Allard, 1895, *Ann. Soc. ent. Belg.*, *39*:225 (Belgaum, Thorawady).
Bruchus gonagra: Fabricius, 1801, *Systema Eleutheratorum, 2*:399. Gyllenhal, in Schonherr, 1833, *Genera et Species Curculionidum, 1*:129.
Pachymerus gonagra Pic, 1913, *Coleopt. Cat.*, *26*:7. Mukerji & Chatterji, 1951, *Indian J. Ent.*, *13*:19. Mathur & Singh, 1959, *Indian For. Bull.*, *171*(4): 59. Mathur & Singh, 1960, *Indian For. Bull.*, *171*(3):35.
Caryedon gonagra: Bridwell, 1929, *Proc. ent. Soc. Wash.*, *31*(8):146. Mukerji, Menon & Chatterji, 1957, *Proc. R. ent. Soc. Lond.*, (B) *26*:103.
Caryedon gonagra, Southgate & Pope, 1957, *Ann. Mag. nat. Hist.*, (12)*10*:669.
Caryedon fuscus Mukerji, Menon & Chatterji, 1957, *Proc. R. ent. Soc. Lond.*, (B) *26*:103-106 nec Goeze.
Hosts—This is the true groundnut bruchid, its various records on *Acacia* spp. & Tamarind are considered doubtful and need to be verified.
Distribution—India, Africa.
I.A.R.I.; P.U.; F.R.I.

67. **Caryedon languidus** Gyllenhal

Caryedon languidus Gyllenhal, in Schonherr, 1839, *Genera et Species Curculionidum, 5*:129 (Calcutta & Manila).
Mylabris (= *Bruchus*) *languidus* Baudi, 1886, *Milabridi*, 1886:107.
Caryoborus languidus: Allard, 1895, *Ann. Soc. ent. Belg.*, *39*:225. Roonwal, Bhashin & Singh, 1956, *Indian For. Bull.*, *171*(1):80.

Host—*Cassia auriculata* (seeds).
Distribution—India, Philippine Islands.
I.A.R.I.; P.U.; F.R.I.

68. **Caryedon tamarindi** (Decaux) Comb. Nov.

Pachymerus tamarindi Decaux, 1894, Le Natural, *16*:129 (India). Pic, 1913, *Coleopt. Cat., 26*:9. Shomar, 1964, *Bull. Soc. ent. Egypte, 47*:191, figs. 186-202 (Egypt, India).
Host—*Tamarindus indicus.*
Distribution—India, Egypt.

Genus 9. *Caryopemon* Jekel (1855)
Type species—*Caryopemon hieroglyphicus* Jekel

69. **Caryopemon lucteonotatus** Pic

Caryopemon lucteonotatus Pic, 1898, *Bull. Soc. Zool. Fr., 23*:173 (India—Paris Mus.). Pic, 1913, *Coleopt. Cat., 26*:9.
Distribution—India.
I.A.R.I.

70. **Caryopemon lhostei** Pic

Caryopemon thostei Pic, 1924, *Echange, 39*:30.
Distribution—Sri Lanka.

Subfamily: Amblycerinae
Genus 10. *Spermophagus* Schonherr (1833) in part.

71. **Spermophagus abdominalis** (Fabricius)

Bruchus abdominalis Fabricius, 1781, *Species Insectorum...., 1*:76 (India Or.). Fabricius, 1801, *Systema Eleutheratorum,* 2:400 (India). Pic, 1913, *Coleopt. Cat., 26*:13.
Spermophagus abdominalis: Chevrolet, 1877, *Ann. Soc. ent. Fr., Bull.,* (5)*7*: 135 (Pondicherry). Mukerji & Chatterji, 1951, *Indian J. ent., 13*:17, pl. iv, fig. 29. (genitalia).
Host—*Hibiscus cannabinus* Linn. (seeds).
Distribution—India.
F.R.I.

72. **Spermophagus aeneipennis** Pic

Spermophagus aeneipennis Pic, 1917, *Mel. exot. ent., 26*:9 (Ceylon).
Distribution—Ceylon.

73. **Spermophagus albofasciatus** Gyllenhal

Spermophagus albofasciatus Gyllenhal, in Schonherr, 1833, *Genera et Species Curculionidum, 1*:110. Pic, 1913, *Coleopt. Cat., 26*:58.
Distribution—India.
I.A.R.I.; P.U.

74. **Spermophagus albosparsus** Gyllenhal

Spermophagus albosparsus Gyllenhal, in Schonherr, 1833, *Genera et Species Curculionidum, 1*:110 (India Or.). Pic. 1913, *Coleopt. Cat., 26*:58.
Distribution—India.
P.U.

75. **Spermophagus bifasciatus** Motschulsky

Spermophagus bifasciatus Motschulsky, 1874, *Bull. Soc. Imp. Nat. Moscou, 39*: 250 (1873) (Agra). Pic, 1913, *Coleopt. Cat., 26*:58.
Distribution—India.

76. **Spermophagus ceylonicus** Pic

Spermophagús ceylonicus Pic, 1917, *Mel. exot. ent., 26*:9 (Ceylon).
Distribution—Sri Lanka.

77. **Spermophagus convolvuli** Thunberg

Spermophagus convolvuli: Thunberg, 1816, *K. Vet. Ak. Handl., 37*:44, 46 (Sudrussland). Schonherr, 1833, *Genera et Species Curculionidum, 1*:113 (Ceylon). Gyllenhal, in Schonherr, 1839, *Genera et Species Curculionidum, 5*:141. Allard, 1868, *Ann. Soc. ent. Belg., 11*:87. Schilsky, 1905, *Kaf. Eur., 16*:E. Pic, 1913, *Coleopt, Cat., 26*:59. Mukerji & Chatterji, 1951, *Indian J. ent., 13*:18-19, pl. viii, figs. 1-3. Mathur & Singh, 1960, *India For. Bull., 171*(5):46.
Spermophagus guttulatus Schonherr, 1839, *Genera et Species Curculionidum, 5*:141.
Host—*Hibiscus cannabinus* (seeds).
Distribution—Ceylon.
I.A.R.I.; F.R.I.

78. **Spermophagus ligatus** Chevrolet

Spermophagus ligatus Chevrolet, 1877, *Ann. Soc. ent. Fr. Bull.*, (5)*7*:134 (Nilgiris). Pic, 1913, *Coleopt. Cat., 26*:60 (N. India).
Distribution—India.

79. **Spermophagus negligens andamanensis** Pic

Spermophagus negligens Lombok var. *andamanensis* Pic, 1917, *Mel. exot. ent., 26*:10 (Andaman Islands).
Distribution—India, Andaman Islands.

80. **Spermophagus niger** Motschulsky

Spermophagus niger Motschulsky, 1866, *Bull. Soc. Imp. Nat. Moscou, 39*:405 (Ceylon). Pic, 1913, *Coleopt. Cat., 26*:60.
Distribution—Ceylon.

81. **Spermophagus notatipennis** Pic

Spermophagus natatipennis Pic, 1932, *Ann. Mag. nat. Hist.*, (10)*9*:332 (Madras, N. Salem, Jawalagiri, Coorg: Fraserpet—Brit. Mus. & Paris Mus.).

Distribution—India.
F.R.I.

82. **Spermophagus rufipennis** Pic

Spermophagus rufipennis Pic, 1917, *Mel. exot. ent., 26*:9 (Cochin).
Distribution—India.

83. **Spermophagus sophrae** Fahrreus

Spermophagus sophrae Fahrreus, in Schonherr, 1839, *Genera et Species Curculionidum, 5*:136 (Chili). Blanchard, in Gay, 1851, *Hist. Chile,* 5:296. Allard, 1895, *Ann. Soc. ent. Belg., 39*:288. (Dharwar). Pic, 1913, *Coleopt. Cat., 26*:62 (India; Chili).
Host—Rose Flowers.
Distribution—Chili, India.

84. **Spermophagus sublineatus** Bohemann

Spermophagus sublineatus Bohemann, in Schonherr, 1839, *Genera et Species Curculionidum, 5*:140 (India Or.). Allard, 1895, *Ann. Soc. ent. Belg., 39*: 228 (Dharwar, Belgaum). Pic, 1913, *Coleopt. Cat., 26*:62.
Hosts—*Spomero coccineo;* Rose flowers.
Distribution—India.

85. **Spermophagus subsignatus** Gyllenhal

Spermophagus subsignatus Gyllenhal, in Schonherr, 1839, *Genera et Species Curculionidum, 5*:139 (India Or.). Allard, 1895, *Ann. Soc. ent. Belg., 39*: 228 (Belgaum & Burma). Pic, 1913, *Coleopt. Cat., 26*:62.
Distribution—India, Burma.

86. **Spermophagus tessellatus** Motschulsky

Spermophagus tessellatus Motschulsky, 1858, *Etudes Entomologiques, 7*:97 (Burma). Pic, 1913, *Coleopt. Cat., 26*:62. Mukerji & Chatterji, 1951, *Indian J. ent., 13*:19, pl. vii, figs. 5-6 (genitalia).
Distribution—India, Burma.

87. **Spermophagus uniformis** Pic

Spermophagus uniformis Pic, 1932, *Ann. Mag. nat. Hist.,* (10)*9*:332 (Coorg: Fraserpet—Brit. Mus. & Paris Mus.).
Distribution—India.
F.R.I.

Genus 11 *Zabrotes* Horn (1885)
Type Species—*Zabrotes cruciger* Horn

88. **Zabrotes subfasciatus** (Bohemann)

Spermophagus subfasciatus Bohemann, in Schonherr, 1833, *Genera et Species Curculionidum, 1*:111 (Brazil). Lucas, 1858, *Ann. Soc. ent. Fr., Bull.,* (3)*6*:28. Allard, 1868, *Ann. Soc. ent. Fr., 11*:87. Decaus, 1890, *Et. Ins. nuis.,*

1890:12. Pic, 1913, *Coleopt. Cat.*, *26*:62 (Africa, Central America). Lepesme, 1941, *Rev. fr. Ent.*, *8*(4):200-201, fig. 1. Shomar, 1964, *Bull. Soc. ent. Egypte*, *47*:195, fig. 219.

Spermophagus (*Zabrotes*) *subfasciatus*: Hoffmann, 1945, *Fn. France*, *44*:104.

Zabrotes subfasciatus: Luk Yanovica & Ter Minasyan, 1957, *Fn. USSR*, Coleoptera, Bruchidae, *24*(1):199.

Spermophagus musculus Bohemann, 1833, in Schonherr, *Genera et Species Curculionidum*, *1*:112 (Brazil).

Spermophagus dorsopictum Lepesme, 1941, *Rev. fr. Ent.*, *8*(4):200.

Distribution—Cosmopolitan.

P.U.

Grasses of Bihar, Orissa and West Bengal[1]

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The paper lists 489 species and varieties belonging to 155 genera of grasses occurring in Bihar, Orissa and West Bengal. The occurrence of the taxa in one or more of these three States is indicated. 32 taxa are reported as new distributional records for these States.

The States of Bihar, Orissa and West Bengal constitute the lower or eastern part of the Gangetic Plain. Clarke (1898) and Chatterjee (1939) regarded the Gangetic Plain (comprising almost entire Uttar Pradesh, Bihar, Orissa and West Bengal, and large parts of eastern Rajasthan and northern Madhya Pradesh) as a distinct phytogeographical region of India.

The senior author, in collaboration with Prof. M. B. Raizada, studied the grasses of Upper Gangetic Plains (comprising Uttar Pradesh, eastern parts of Rajasthan and northern parts of Madhya Pradesh) over a number of years (Raizada *et al.* 1961; Raizada & Jain 1965, 1966). It was considered useful to extend the studies to the remaining parts of the Gangetic Plain i.e. lower Gangetic plains in the States of Bihar, Orissa and West Bengal.

The present work was, however, not confined only to the plains, and in order to facilitate the revision of the family Poaceae for the floras of these three States, the present political boundaries of these States were taken as the area of study, this meant inclusion of the hilly regions.

Prain's (1903) book is the only work dealing with the plants of Bengal State as a whole. Among later works, which deal with grasses of this state, the following may be mentioned—Banerjee (1968), Chakravarty (1957), Chaudhuri (1959a, b; 1960a, b; 1965), Datta & Maiti (1963), Datta & Majumdar (1966), Majumdar (1956), Mallick (1966), Matthew (1966) and Paul & Bhattacharya (1959).

Hara's work (1966) on eastern Himalayas also covers Darjeeling hills.

For Bihar and Orissa, comparatively more recent works are avail-

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able; namely the Botany of Bihar and Orissa by Haines (1925); and its supplement by Mooney (1950). The southern part of Orissa was formerly in Madras Presidency; and was covered by Fischer's (1934) work. A few later works, such as lists of grasses or tour reports for some districts or smaller regions of these states are also available; such as—Bal (1942), Banerjee & Banerjee (1968), Bharadwaja (1958), Bressers (1951), Kanodia & Mallick (1966), Mukherjee (1956), Panigrahi (1966), Panigrahi *et al.* (1964), Paul (1967), Raizada (1949), Raju (1964), Sanyal (1957), Singh & Verma (1964), Srivastava (1954, 1955, 1956a, b, 1959) and Thothathri *et al.* (1966).

We have made collections in these states, and have studied the vast collections deposited in the Central National Herbarium. The collections lodged in the herbaria of the Eden Gardens, Calcutta, Central Rice Research Institute and Ravenshaw College, Cuttack have also been consulted.

The following list includes all the species and varieties of grasses reported from Bihar, Orissa and West Bengal; the list includes 155 genera, and 489 species and varieties. The arrangement of the taxa is, in general, according to Bor (1960); namely, first the subfamily Panicoideae and then the subfamily Pooideae. Under the sub-families, the tribes; under the tribes, the genera; and under the genera the species are arranged alphabetically. The nomenclature has been verified with the works of Bor (loc. cit.), Raizada (1959), Jain (1967b) and WEALTH OF INDIA (1962, 1966, 1969).

Only current botanical names are given. Synonyms and information on distribution, etc. can be seen in Bor's book, for which a reference has been given. When a species is not given in Bor's book (e.g. all Bambuseae), a reference is made to Hooker's (1896) account of Indian grasses, or some other relevant work.

The occurrence of most of these species in this region has been verified by actual specimens collected by us in the field or studied by us in the herbaria. The occurrence of a species in the three states is shown by the following abbreviations:

B : Bengal
Bi: Bihar
O : Orissa

This abbreviation in small capital type indicates that actual specimens for that state have been seen by us; ordinary type means that the report from that state is based on published literature.

The jurisdiction of Prain's (1903) flora was much wider than the present boundaries of West Bengal, and therefore, several species included in Prain's book may not be found marked for Bengal (i.e. B).

Species which are largely cultivated for cereal or fodder, etc. are

included, and are marked C; for such species the names of the states are omitted. Species cultivated only on experimental scale are not included.

NEW RECORDS

The present study has led to the discovery of several additional species of grasses from Bengal, Bihar and Orissa, i.e. taxa not so far reported from these states, and in a few cases from India as a whole, in any published work. Such names are marked with a special sign; namely asterisk (*) for Bengal, plus (+) for Bihar and O (O) for Orissa. The taxa which are new records for India, are marked @. These instances of new distributional records are based on authors' own examination of specimens; instances arising out of mere published information are not included. A reference has been given, where more details about some of these new records can be seen.

The bibliography includes only important references on floristics, particularly on grasses, of the region.

Subfamily: PANICOIDEAE
Tribe: ANDROPOGONEAE

Andropogon ascinodis C. B. Clarke. Bor 90. (BI, O).

Andropogon pumilus Roxb. Bor 93. (B, Bi, O).

Apluda mutica Linn. Bor 93. (B, BI, O).

Apocopis courtallumensis (Steud.) Henr. Bor 95. (BI).

Apocopis paleacea (Trin.) Hochr. Bor 96. (B, Bi).

Apocopis vaginata Hack. Bor 96. (BI, O).

Arthraxon castratus (Griff.) Narayan. ex Bor. Bor 99. (Bi).

Arthraxon echinatus Hochst. Bor 99. (O).

Arthraxon hispidus (Thunb.) Makino. Bor 99. (B, BI).

Arthraxon lancifolius (Trin.) Hochst. Bor 100. (B, BI).

Arthraxon nudus Hochst. Bor 101. (B, BI, O).

Arthraxon prionodes (Steud.) Dandy. Bor 101. (BI).

+ *Arthraxon quartinianus* (Rich.) Nash. Bor 102. (BI).

Bothriochloa glabra (Roxb.) A. Camus. Bor 107. (B, BI).

Bothriochloa intermedia (R. Br.) A. Camus var. *intermedia*. Bor 108. (B, Bi).

Bothriochloa intermedia var. *punctata* (Roxb.) Keng. Bor 108. (B, BI, O).

Bothriochloa ischaemum (Linn.) Keng. Bor 108. (B).

Bothriochloa kuntzeana (Hack.) Henr. Bor 108. (Bi).

Bothriochloa odorata (Lisboa) A. Camus. Bor 109. (BI).

Bothriochloa pertusa (Linn.) A. Camus. Bor 110. (B, BI, O).

Capillipedium assimile (Steud.) A. Camus. Bor 110. (B, BI, O).

Capillipedium parviflorum (R. Br.) Stapf. Bor 112. (B, Bi, O).

Chrysopogon aciculatus (Retz.) Trin. Bor 115. (B, Bi, O).

Chrysopogon fulvus (Spreng.) Chiov. Bor 116. (BI, O).

Chrysopogon gryllus (Linn.) Trin. Bor 117. (B, Bi).

Chrysopogon hamiltonii (Hook. f.)

Haines. Bor 117. (BI).
Chrysopogon lancearius (Hook. f.) Haines. Bor 118. (B, BI, O).
Chrysopogon polyphyllus (Hack.) Blatt. et McCann. Bor 118. (Bi).
Chrysopogon serrulatus Trin. Bor 118. (BI).
* *Coelorhachis khasiana* (Hack.) Stapf ex Bor. Bor 121. (B).
Coelorhachis striata (Nees ex Steud.) A. Camus var. *striata*. Bor 121. (B).
Cymbopogon caesius (Nees) Stapf. Bor 125. (Bi, O).
+ *Cymbopogon citratus* (DC.) Stapf. Bor 126. (B, BI).
Cymbopogon flexuosus (Nees ex Steud.) Wats. Bor 127. (B, Bi).
Cymbopogon flexuosus (Nees ex Steud.) Wats. var. *microstachys* (Hook. f.) Bor. Bor 127. (BI).
Cymbopogon gidarba (Ham. ex Hook. f.) Haines. Bor 128. (BI, O)
Cymbopogon hookeri (Munro ex Hack.) Stapf ex Bor. Bor 128. (B).
Cymbopogon jwarancusa (Jones) Schult. Bor 128. (B, Bi, O).
Cymbopogon khasianus (Hack.) Hack.) Stapf ex Bor. Bor 128. (B).
Cymbopogon martinii (Roxb.) Wats. Bor 129. (B, BI, O).
Cymbopogon microtheca (Hook. f.) A. Camus. Bor 129. (B, Bi).
Cymbopogon nardus (Linn.) Rendle. Bor 130. (B, BI).
Cymbopogon pendulus (Nees ex Steud.) Wats. Bor 131. (B, Bi).
Cymbopogon schoenanthus (Linn.) Spreng. Bor 131. (B).
Dichanthium annulatum (Forssk.) Stapf. Bor 133. (B, BI, O).
Dichanthium aristatum (Poir.) C.E. Hubb. Bor 134. (B, Bi, O).
Dichanthium caricosum (Linn.) A. Camus. Bor 134. (B, Bi, O).
Diectomis fastigiata (Sw.) Kunth. Bor 135. (B, BI, O).
Dimeria connivens Hack. Bor 140. (BI, O).
+ *Dimeria hohenackeri* Hochst. ex Miq. Bor 142. (BI).
Dimeria lehmannii (Nees) Hack. Bor 142. (O).
Dimeria mooneyi Raizada ex Mooney. Bor 142. (O).
Dimeria orissae Bor. Bor 142. (O).
Dimeria ornithopoda Trin. var. *ornithopoda*. Bor 142. (B, BI, O).
Dimeria ornithopoda Trin. var. *gracillima* Bor. Bor 144. (BI).
+ *Dimeria pubescens* Hack. Bor 144. (BI).
@ *Dimeria trimenii* Hook. f. Bor 144. (O).
Eremopogon foveolatus (Del.) Stapf. Bor 148. (B, BI, O).
Erianthus longisetosus Anderss. Bor 151. (B).
Erianthus longisetosus Anderss. var. *hookeri* (Hack.) Bor. Bor 151. (B).
Erianthus ravennae (Linn.) P. Beauv. Bor 151. (B, Bi).
Erianthus rufipilus (Steud.) Griseb. Bor 152. (B).
Erianthus sikkimensis Hook. f. Bor 152. (B).
Eulalia fastigiata (Nees) Haines. Bor 155. (B, Bi).
Eulalia fimbriata (Hack.) O. Ktze. Bor 155. (B).
Eulalia leschenaultiana (Decne.) Ohwi. Bor 155. (B, BI, O).
Eulalia mollis (Griseb.) O. Ktze. Bor 156. (B).
Eulalia quadrinervis (Hack.) O. Ktze. Bor 156. (B).
Eulalia trispicata (Schult.) Henr. Bor 157. (B, BI, O).
Eulaliopsis binata (Retz.) C. E. Hubbard. Bor 158. (B, BI, O).
Hackelochloa granularis (Linn.) O. Ktze. Bor 159. (B, BI, O).
Hackelochloa porifera (Hack.) Rhind. Bor 160. (B).
Hemarthria compressa (Linn. f.) R. Br. Bor 161. (B, BI, O).
Hemarthria protensa Steud. Bor 161. (B, BI).
Heteropogon contortus (Linn.) P. Beauv. ex Roem. et Schult. Bor 163. (B, BI, O).
Heteropogon melanocarpus (Ell.) Benth. Bor 165. (Bi, O).

Hyparrhenia rufa (Nees) Stapf. Bor 167. (B).
Imperata cylindrica (Linn.) P. Beauv. Bor 169. (B, BI, O).
Imperata cylindrica (Linn.) P. Beauv. var. *major* (Nees) Hubb. et Vaugh. (B).
Indochloa clarkei (Hack.) Bor. Bor 171. (BI).
Ischaemum duthiei Stapf ex Bor. Bor 178. (B, BI).
Ischaemum hirtum Hack. Bor 179. (BI).
Ischaemum indicum (Houtt.) Merrill. Bor 180. (B, BI, O).
Ischaemum rugosum Salisb. Bor 184. (B, BI, O).
Ischaemum semisagittatum Roxb. Bor 185. (B).
Ischaemum timorense Kunth. Bor 185. (B, Bi).
* *Iseilema anthephoroides* Hack. Bor 187. (B, Bi, O).
Iseilema holei Haines. Bor 188. (Bi).
Iseilema laxum Hack. Bor 188, (B, BI, O).
Iseilema prostratum (Linn.) Anderss. Bor 188. (B, BI, O).
Lophopogon kingii Hook. f. Bor 190. (BI).
Manisuris clarkei (Hack.) Bor apud Santapau. Bor 191. (BI, O).
Microstegium ciliatum (Trin.) A. Camus. Bor 193. (B, BI, O).
Microstegium nudum (Trin.) A. Camus. Bor 194. (B).
Microstegium petiolare (Trin.) Bor. Bor 194. (O).
* *Microstegium vagans* (Nees ex Steud.) A. Camus. Bor 195. (B).
Microstegium vimineum (Trin.) A. Camus. (B).
Miscanthus nepalensis (Trin.) Hack. Bor 196. (B).
Miscanthus nudipes (Griseb.) Hack. Bor 196. (B).
Mnesithea laevis (Retz.) Kunth. Bor 197. (B, BI, O).
Narenga fallax (Balansa) Bor. Bor 198. (B, Bi).
Narenga porphyrocoma (Hance) Bor. Bor 198. (B, BI, O).
Ophiuros exaltatus (Linn.) O. Ktze. Bor 199. (B, Bi).
Ophiuros megaphyllus Stapf ex Haines. Bor 199. (B, Bi).
O *Pogonatherum crinitum* (Thunb.) Kunth. Bor 200. (B, Bi, O).
Pogonatherum paniceum (Lamk.) Hack. Bor 202. (B, BI, O).
Pogonatherum rufo-barbatum Griff. Bor 202 (O).
@ *Polytrias amaura* (Buse) O. Ktze. Bor 202 (B). [Jain & Pal 1968].
Pseudanthistiria heteroclita (Roxb.) Hook. f. Bor 203. (B).
Pseudopogonatherum contortum (Brongn.) A. Camus. Bor 204. (B, BI).
Pseudosorghum fasciculare (Roxb.) A. Camus. Bor 205. (B, BI, O).
Rottboellia exaltata Linn. f. Bor 206. (B, BI, O).
Saccharum arundinaceum Retz. Bor 211. (B, BI).
Saccharum bengalense Retz. Bor 211. (B, BI, O).
Saccharum officinarum Linn. Bor 212. (C).
Saccharum procerum Roxb. Bor 213. (B).
Saccharum spontaneum Linn. Bor 214. (B, BI, O).
Schizachyrium brevifolium (Sw.) Nees ex Buse. Bor 215. (B, BI, O).
Schizachyrium exile (Hochst.) Stapf. Bor 216. (B, BI, O).
Sclerostachya fusca (Roxb.) A. Camus. Bor 217. (B, Bi).
Sehima nervosum (Rottl.) Stapf. Bor 218. (B, BI).
Sorghum cernuum Host. var. *globosum* (Hack.) Snowden. Bor 231. (C).
Sorghum cernuum Host. var. *yemense* (Koern.) Snowden. Bor 231. (C).
Sorghum conspicuum Snowden. var. *orientale* Snowden. Bor 232. (C).
Sorghum conspicuum Snowden. var. *usaramense* (Busse et Pilger) Snowden. Bor 232. (C).
Sorghum controversum (Steud.) Snowden. 222. (B, BI).
Sorghum halepense (Linn.) Pers. Bor 222. (C).

Sorghum miliiforme (Hack.) Snowden var. *miliiforme*. Bor 239. (C).
Sorghum miliiforme (Hack.) Snowden var. *rotundulum* Snowden. Bor 239. (C).
Sorghum nervosum Bess. ex Schult. Bor 239. (C).
Sorghum nitidum (Vahl) Pers. Bor 245. (BI).
Sorghum roxburghii Stapf var. *nanum* Snowden. Bor 241. (C).
Sorghum vulgare Pers. (C).
Thaumastochloa cochinchinensis (Lour.) C. E. Hubb. Bor 247. (BI)
Themeda arundinacea (Roxb.) Ridley. Bor 250. (B, BI, O).
Themeda caudata (Nees) A. Camus. Bor 250. (B, BI, O).
Themeda hookeri (Griseb.) A. Camus. Bor 251. (B).
Themeda laxa (Anderss.) A. Camus. Bor 251. (Bi, O).
Themeda mooneyi Bor. Bor 252. (O).
Themeda quadrivalvis (Linn.) O. Ktze. Bor 252. (B, BI, O).
Themeda saxicola Bor. Bor 252. (O).
Themeda strigosa (Ham. ex Hook.f.) A. Camus. Bor 252. (B, BI).
Themeda triandra Forssk. Bor 254. (B, BI, O).
Themeda villosa (Poir.) A. Camus. Bor 254. (B, Bi, O).
Thyrsia zea (Clarke) Stapf. Bor 255. (B).
Vetiveria zizanioides (Linn.) Nash. Bor 258. (B, BI, O).
Vossia cuspidata (Roxb.) Griff. Bor 259. (B).

Tribe: MAYDEAE

Chionachne koenigii (Spreng.) Thw. Bor 262. (B, BI, O).
Coix aquatica Roxb. Bor 264. (B, BI, O).
Coix gigantea Koenig ex Roxb. Bor 264. (B, BI, O).
Coix lacryma-jobi Linn. var. *lacryma-jobi*. Bor 265. (B, BI, O).
* *Coix lacryma-jobi* Linn. var. *mayuen* (Romanet) Stapf. Bor 265. (B, O).
Polytoca digitata (Linn. f.) Druce. Bor 267. (B, Bi).
Zea mays Linn. Bor 270. (C).

Tribe: PANICEAE

Acroceras munroanum (Balansa) Henr. Bor 275. (B).
Acroceras zizanioides (H.B.K.) Dandy. Bor 275. (B).
Alloteropsis cimicina (Linn.) Stapf. Bor 276. (B, BI, O).
Alloteropsis semialata (R. Br.) Hitchc. Bor 276. (BI).
Axonopus compressus (Swartz.) P. Beauv. Bor 278. (B).
Brachiaria distachya (Linn.) Stapf. Bor 281. (B, BI, O).
Brachiaria eruciformis (J.E. Sm.) Griseb. Bor 283. (B, BI, O).
Brachiaria kurzii (Hook. f.) A. Camus. Bor 283 (B, BI).
\+ *Brachiaria miliiformis* (Presl.) A. Chase. Bor 283. (B, BI).
O *Brachiaria mutica* (Forssk.) Stapf. Bor 284. (B, O).
Brachiaria ramosa (Linn.) Stapf. Bor 284. (B, BI, O).
Brachiaria remota (Retz.) Haines. Bor 285. (B, O).
Brachiaria reptans (Linn.) Gard. et C. E. Hubb. Bor 285. (B, BI, O).
Brachiaria setigera (Retz.) C. E. Hubb. Bor 286. (B, BI).
*+ *Brachiaria subquadripara* (Trin.) Hitchc. Bor 286. (B, BI) [Banerjee 1971a]
* *Brachiaria villosa* (Lamk.) A. Camus var. *barbata* Bor. Bor 286. (B). [Banerjee 1971a]
Cenchrus ciliaris Linn. Bor 287. (B, Bi).
Cenchrus echinatus Linn. Bor 287. (B).
Cenchrus pennisetiformis Hochst. et

Steud. ex Steud. Bor 289. (Bi).
Cyrtococcum accrescens (Trin.) Stapf. Bor 291. (B).
Cyrtococcum oxyphyllum (Steud.) Stapf. Bor 291. (B, Bi, O).
Cyrtococcum patens (Linn.) A. Camus. Bor 292. (B, Bi, O).
Cyrtococcum trigonum (Retz.) A. Camus. Bor 292. (B).
Digitaria adscendens (H.B.K.) Henr. Bor 298. (B, BI, O).
Digitaria adscendens (H.B.K.) Henr. subsp. *chrysoblephara* (Fig. et. de Not.) Henr. Bor 299. (B, BI).
Digitaria bicornis (Lamk.) Roem. et Schult. ex Loud. Bor 299. (B, BI).
+ *Digitaria biformis* Willd. Bor 299. (BI, O).
Digitaria cruciata (Nees) A. Camus. Bor 300. (B, BI).
Digitaria fuscescens (Presl) Henr. Bor 301. (B).
Digitaria granularis (Trin.) Henr. Bor 301. (B, BI, O).
Digitaria longiflora (Retz.) Pers. Bor 302. (B, BI, O).
Digitaria pentzii Stent. Bor 304. (B).
*+ *Digitaria preslii* (Kunth.) Henr. Bor 304. (B, BI). [Banerjee 1968]
Digitaria sanguinalis (Linn.) Scop. Bor 304. (B, BI, O).
Digitaria setigera Roth apud Roem. et Schult. Bor 305. (B, BI).
Digitaria stricta Roth ex Roem. et Schult. Bor 305. (B, BI, O).
+ *Digitaria thwaitesii* (Hack.) Henr. Bor 306. (BI).
Digitaria timorensis (Kunth.) Bal. Bor 306. (B).
Digitaria violascens Link. Bor 307. (B).
Echinochloa colonum (Linn.) Link. Bor 308. (B, BI, O).
Echinochloa crusgalli (Linn.) P. Beauv. Bor 310. (B, BI, O).
Echinochloa crusgalli (Linn.) P. Beauv. var. *breviseta* (Doell) Neilr. Bor 310. (B).
* *Echinochloa cruspavonis* (H.B.K.) Schult. Bor 310 (B). [Banerjee 1971a]
Echinochloa frumentacea Link. Bor 311. (B, BI, O).
Echinochloa stagnina (Retz.) P. Beauv. Bor 311. (B, BI, O).
Eriochloa procera (Retz.) C. E. Hubbard. Bor 312. (B, BI, O).
Hymenachne pseudointerrupta C. Muell. Bor 313. (B, BI, O).
Ichnanthus vicinus (F. M. Bail.) Merr. Bor 314. (O).
* *Melinis minutiflora* P. Beauv. Bor 315. (B).
Oplismenus burmannii (Retz.) P. Beauv. Bor 317. (B, BI, O).
Oplismenus compositus (Linn.) P. Beauv. Bor 317. (B, Bi, O).
Panicum antidotale Retz. Bor 322. (B, BI, O).
Panicum atrosanguineum Hochst. ex A. Rich. Bor 322. (B, Bi O).
Panicum auritum Presl ex Nees. Bor 324. (B, Bi, O).
Panicum austroasiaticum Ohwi. Bor 324. (B, BI, O).
Panicum brevifolium Linn. Bor 324. (B, Bi, O).
Panicum cambogiense Balansa. Bor 325. (B, Bi).
@ *Panicum elegantissimum* Hook. f. Bor 325. (B) [Banerjee 1971b].
Panicum fasciculatum Sw. Majumdar 52. (B).
Panicum humidorum Buch-Ham. ex Hook. f. Bor 326. (B).
Panicum incomtum Trin. Bor 326. (B).
Panicum khasianum Munro ex Hook. f. Bor 327. (B).
Panicum maximum Jacq. Bor 327. (B, BI).
Panicum miliaceum Linn. Bor 327. (B, BI, O).
Panicum notatum Retz. Bor 701. (B, BI, O).
Panicum paludosum Roxb. Bor 329. (B, BI, O).
Panicum psilopodium Trin. Bor 329. (B, BI, O).
* *Panicum psilopodium* Trin. var. *coloratum* Hook. f. (B) [Pal & Banerjee 1970].
Panicum repens Linn. Bor 330. (B, BI, O).
Panicum sarmentosum Roxb.

Bor 330. (B).
Panicum sumatranse Roth. ex Roem. et Schult. Bor 701. (B, BI, O).
Panicum trypheron Schult. Bor 331. (B, BI, O).
Paspalidium flavidum (Retz.) A. Camus. Bor 333. (B, BI, O).
Paspalidium geminatum (Forssk.) Stapf. Bor 333. (O).
Paspalidium punctatum (Burm.) A. Camus. Bor 333. (B, BI, O).
Paspalum cartilagineum J. S. Presl ex C. B. Presl. Bor 335. (BI).
Paspalum conjugatum Berg. Bor 336. (B).
Paspalum dilatatum Poir. Bor 338. (B).
Paspalum distichum Linn. Bor 338. (B, BI).
Paspalum orbiculare Forst. Bor 340. (B).
Paspalum scrobiculatum Linn. Bor 340. (B, BI, O).
Paspalum vaginatum Swartz. Bor 341. (BI).
Pennisetum clandestinum Hochst. ex Chiov. Bor 344. (B).
Pennisetum hohenackeri Hochst. ex Steud. Bor 344. (Bi, O).
Pennisetum hordeoides (Lamk.) Steud. Bor 345. (BI, O).
Pennisetum orientale L. C. Rich. Bor 345. (B, BI).
Pennisetum orientale L. C. Rich. var. *triflorum* Stapf. Bor 346. (Bi).
Pennisetum pedicellatum Trin. Bor 346. (B, BI).
Pennisetum polystachyon (Linn.) Schult. Bor 346. (B, BI, O).
Pennisetum purpureum Schumach. Bor 348. (B, Bi, O).
Pennisetum setosum (Swartz.) L. C. Rich. Bor 348. (B, BI, O).
Pennisetum typhoides (Burm.) Stapf et C. E. Hubb. Bor 350. (C).
Pseudechinolaena polystachya (H.B.K.) Stapf. Bor 352. (B).
Pseudoraphis brunoniana Griff. Bor 353. (B, Bi, O).
Pseudoraphis minuta (Mez) Pilger. Bor 353. (B, Bi, O).
Pseudoraphis spinescens (R. Br.) Vickery. Bor 353. (B, Bi).
Pseudoraphis spinescens (R. Br.) Vickery var. *depauperata* (Nees) Bor. Bor 354. (B).
Sacciolepis indica (Linn.) A. Chase. Bor 357. (B, BI, O).
Sacciolepis interrupta (Willd.) Stapf. Bor 358. (B, BI, O).
Sacciolepis myosuroides (R. Br.) A. Camus. Bor 358. (B, BI, O).
Setaria barbata (Lamk.) Kunth. Bor 360. (B, Bi).
Setaria glauca (L.) P. Beauv. Bor 360. (B, BI, O).
Setaria italica (Linn.) P. Beauv. Bor 362. (B, BI).
Setaria pallide-fusca (Schumach.) Stapf et C. E. Hubb. Bor 363. (B, BI, O).
Setaria palmifolia (Koen.) Stapf. Bor 363. (B, BI, O).
* *Setaria paniculifera* (Steud.) Fourn. ex Hemsl. Bor 363. (B).
Setaria plicata (Lamk.) T. Cooke. Bor 364. (B, BI, O).
Setaria tomentosa (Roxb.) Kunth. Bor 365. (B, BI, O).
Setaria verticillata (Linn.) P. Beauv. Bor 365. (B, BI, O).
Setaria viridis (Linn.) P. Beauv. Bor 365. (B).
Spinifex littoreus (Burm. f.) Merr. Bor 366. (B, O).
* *Stenotaphrum dimidiatum* (Linn.) Brongn. Bor 366. (B).
O *Trachys muricata* (Linn.) Pers. ex Trin. Bor 369. (O).
Urochloa panicoides P. Beauv. Bor 372. (B, Bi, O).
Urochloa panicoides P. Beauv. var. *pubescens* (Kunth.) Bor. Bor 372. (BI).

Subfamily: POOIDEAE

Tribe: AELUROPODEAE

Aeluropus lagopoides (Linn.) Trin. ex Thw. Bor 380. (B).

Tribe: AGROSTIDEAE

Agrostis brachiata Munro ex Hook. f. Bor 386. (BI).

Agrostis filipes Hook. f. Bor 387. (B).

Agrostis gigantea Roth. Bor 387. (B).

Agrostis inaequiglumis Griseb. Bor 387. (B).

Agrostis micrantha Steud. Bor 388. (B).

Agrostis myriantha Hook. f. Bor 388. (B).

Agrostis nervosa Nees ex Trin. Bor 388. (B).

Agrostis pilosula Trin. var. *pilosula*. Bor 388. (B).

Agrostis pilosula Trin. var. *ciliata* (Trin.) Bor. Bor 389. (B).

Agrostis sikkimensis Bor. Bor 390. (B).

Agrostis triaristata (Hook. f.) Bor. Bor 391. (B).

Agrostis zenkeri Trin. Bor 392. (B).

Calamagrostis emodensis Griseb. Bor 395. (B).

Deyeuxia pulchella (Griseb.) Hook. f. Bor 399. (B).

Deyeuxia scabrescens (Griseb.) Munro ex Duthie. Bor 399. (B).

Muhlenbergia huegelii Trin. Bor 401. (B).

Phleum alpinum Linn. Bor 402. (B).

Polypogon fugax Nees ex Steud. Bor 403. (B, BI).

Polypogon monospeliensis (Linn.) Desf. Bor 403. (B, BI).

Tribe: ARISTIDEAE

Aristida adscensionis Linn. Bor 407. (B, BI, O).

Aristida cumingiana Trin. et Rupr. Bor 409. (B, BI, O).

Aristida cyanantha Nees ex Steud. Bor 409. (B).

Aristida depressa Retz. Bor 409. (B).

Aristida funiculata Trin. et Rupr. Bor 410. (B, BI, O).

Aristida hystrix Linn. f. Bor 410. (Bi, O).

Aristida redacta Stapf. Bor 412. (B, BI).

Aristida setacea Retz. Bor 412. (B, BI, O).

Tribe: ARUNDINEAE

Arundo donax Linn. Bor 413. (B, BI, O).

Phragmites karka (Retz.) Trin. ex Steud. var. *karka*. Bor 416. (B, BI, O).

Phragmites karka (Retz.) Trin. ex Steud. var. *cincta* Hook. f. , Bor 416. (B).

Tribe: ARUNDINELLEAE

Arundinella bengalensis (Spreng.) Druce. Bor 421. (B, BI, O).

Arundinella decempedalis (O. Ktze.) Janowski. Bor 422. (B).

Arundinella holcoides (Kunth.) Trin. Bor 422. (B, Bi, O).

Arundinella hookeri Munro ex Keng. Bor 422. (B).

Arundinella intricata Hughes. Bor 422. (B).

Arundinella nepalensis Trin. Bor 423. (B, Bi).

Arundinella pumila (Hochst.) Steud. Bor 423. (BI, O).

Arundinella setosa Trin. Bor 424. (BI, O).

Arundinella villosa Arn. ex Steud. Bor 426. (B).

Jansenella griffithiana (C. Muell.) Bor. Bor 426. (B).

Tribe: AVENEAE

Anthoxanthum hookeri (Griseb.) Rendle. Bor 431. (B).
Anthoxanthum odoratum Linn. Bor 431. (B).
Avena fatua Linn. Bor 434. (B).
Avena sativa Linn. Bor 434. (C).
Deschampsia caespitosa (Linn.) P. Beauv. Bor 435. (B).
Helictotrichon asperum (Munro) Bor. Bor 438. (B).
Helictotrichon virescens (Nees ex Steud.) Henr. Bor 439. (B).
Hierochloa flexuosa Hook. f. Bor 441. (B).
Holcus lanatus Linn. Bor 443. (B).
Holcus mollis Linn. Bor 443. (B).
Koeleria cristata (Linn.) Pers. Bor 444. (B).
Trisetum flavescens (Linn.) P. Beauv. Bor 448. (B).
Trisetum spicatum (Linn.) Richt. Bor 448. (B).

Tribe: BAMBUSEAE

Arundinaria maling Gamble. Bor 1940. 42. (B).
Arundinaria racemosa Munro. Hooker 379. (B).
Bambusa arundinacea (Retz.) Willd. Hooker 395. (B, BI, O).
Bambusa balcooa Roxb. Hooker 391. (B, Bi).
Bambusa nutans Wall. Hooker 387. (B, Bi, O).
*O *Bambusa pallida* Munro. Hooker 389. (B, O).
Bambusa tulda Roxb. Hooker 387. (B, BI, O).
Bambusa vulgaris Schrad. Hooker 391. (B, O).
Cephalostachyum capitatum Munro. Hooker 412. (B).
* *Cephalostachyum fuchsianum* Gamble. Hooker 413. (B).
Cephalostachyum latifolium Munro. Hooker 412. (B).
Cephalostachyum pergracile Munro. Hooker 413. (B, Bi).
Chimonobambusa griffithiana (Munro) Nakai. Hooker 379. (B).
Chimonobambusa hookeriana (Munro) Nakai. Hooker 382. (B).
Chimonobambusa intermedia (Munro) Nakai. Hooker 381. (B).
Dendrocalamus giganteus Munro. Hooker 406. (B).
Dendrocalamus hamiltonii Nees et Arn. Hooker 405. (B, Bi).
Dendrocalamus hookeri Munro. Hooker 405. (B).
Dendrocalamus longispathus Kurz. Hooker 407. (B).
Dendrocalamus patellaris Gamble. Hooker 406. (B).
Dendrocalamus sericeus Munro. Hooker 404. (B, BI, O).
Dendrocalamus sikkimensis Gamble. Hooker 405. (B).
Dendrocalmus strictus Nees. Hooker 404. (B, BI, O).
Neohouzeana dullooa A. Camus. Bor 1940. 21. (B).
Oxytenanthera nigrociliata Munro. Hooker 401. (O).
Pseudostachyum polymorphum Munro. Hooker 409. (B).
Semiarundinaria pantlingii (Gamble) Nakai. Hooker 380. (B).
Thamnocalamus aristatus (Gamble) E. G. Camus. Hooker 382. (B).
Thamnocalamus falconeri Hook. f. Hooker 383. (B).
Thamnocalamus spathiflorus (Trin.) Munro. Hooker 382. (B).

Tribe: BRACHYPODEAE

Brachypodium sylvaticum (Huds.) P. Beauv. Bor 450. (B).

Tribe: BROMEAE

Bromus himalaicus Stapf apud Hook. f. Bor 454. (B).
Bromus japonicus Thunb. Bor 455. (B).
Bromus mollis Linn. Bor 455. (B).
Bromus ramosus Huds. Bor 456. (B).
Bromus tectorum Linn. Bor 456. (B).
Bromus unioloides H.B.K. Bor 456. (B).

Tribe: CENTOTHECEAE

Centotheca lappacea (Linn.) Desv. Bor 457. (B, Bi, O).

Tribe: CHLORIDEAE

Chloris barbata Sw. Bor 465. (B, Bi, O).
Chloris dolichostachya Lagasca. Bor 466. (B, Bi, O).
Chloris montana Roxb. Bor 466. (B, BI).
Chloris roxburghiana Schult. Bor 468. (B).
Chloris virgata Sw. Bor 468. (B, BI).
*+O *Cynodon arcuatus* J. S. Presl ex C. B. Presl. Bor 469. (B, BI, O) [Jain 1967a]
*+ *Cynodon barberi* Rang. et Tad. f. *barberi.* Bor 469. (B, BI) [Jain 1967a]
*+O *Cynodon barberi* Rang. et Tad. f. *longifolius* Jain. (B, BI, O). [Jain 1967a]
Cynodon dactylon (Linn.) Pers. Bor 469. (B, BI, O).
Gymnopogon delicatulus (C. B. Clarke) Bor. Bor 472. (BI, O).
Melanocenchris jacquemontii Jaub. et Spach. Bor 473. (BI, O).
Microchloa indica (Linn. f) P. Beauv. Bor 473. (B, BI, O).
Oropetium thomaeum (Linn. f) Trin. Bor 474. (B, BI).
Oropetium villosulum Stapf ex Bor. Bor 474. (O).
Schoenefeldia gracilis Kunth. Bor 474. (B, BI).

Tribe: DANTHONIEAE

Danthonia cachemyriana Jaub. et Spach. Bor 478. (B).
Danthonia jacquemontii Bor. Bor 478. (B).
Eriachne pallescens R. Br. Bor 479. (B).

Tribe: ERAGROSTEAE

+ *Acrachne racemosa* (Heyne) Ohwi. Bor 487. (B, BI).
Dactyloctenium aegyptium (Linn.) P. Beauv. Bor 489. (B, BI, O).
Dactyloctenium sindicum Boiss. Bor 489. (Bi).
Desmostachya bipinnata (Linn.) Stapf. Bor 491. (B, BI, O).
Dinebra retroflexa (Vahl) Panz. Bor 491. (B, BI).
Diplachne fusca (Linn.) P. Beauv. Bor 492. (B, Bi).
Eleusine coracana (Linn.) Gaertn. Bor 492. (B, Bi, O).
Eleusine indica (Linn.) Gaertn. Bor 493. (B, Bi, O).
Elytrophorus spicatus (Willd.) A. Camus. Bor 493. (B, BI, O).
Eragrostiella bifaria (Vahl) Bor. Bor 494. (B, BI, O).
Eragrostiella brachyphylla (Stapf) Bor. Bor 494. (B, BI, O).
Eragrostiella leioptera (Stapf) Bor. Bor 495. (B, O).
Eragrostiella nardoides (Trin.) Bor. Bor 495. (BI).

Eragrostis cilianensis (All.) Vignolo-Lutati. Bor 503. (B, BI, O).
Eragrostis ciliaris (Linn.) R. Br. Bor 506. (Bi).
Eragrostis ciliata (Roxb.) Nees. Bor 506. (BI, O).
Eragrostis coarctata Stapf. Bor 507. (B, BI, O).
Eragrostis diarrhena (Schult.) Steud. Bor 507. (B, BI, O).
Eragrostis diplachnoides Steud. Bor 508. (B, BI, O).
Eragrostis gangetica (Roxb.) Steud. Bor 508. (B, BI, O).
Eragrostis japonica (Thunb.) Trin. Bor 509. (B, BI, O).
Eragrostis nigra Nees. ex Steud. Bor 511. (B).
Eragrostis nutans (Retz.) Nees ex Steud. Bor 511. (B, BI, O).
Eragrostis pilosa (Linn.) P. Beauv. Bor 512. (B, Bi, O).
Eragrostis poaeoides P. Beauv. Bor 512. (B, Bi).
* *Eragrostis riparia* (Willd.) Nees. Bor 513. (B, O).
Eragrostis tenella (Linn.) P. Beauv. ex Roem. et Schult. var. *tenella*. Bor 514. (B, BI, O).
Eragrostis tenella (Linn.) P. Beauv. ex Roem. et Schult. var. *insularis* C. E. Hubb. Bor 514. (B).
Eragrostis tenuifolia (A. Rich.) Hochst. ex Steud. Bor 514. (B, BI, O).
Eragrostis tremula Hochst. ex Steud. Bor 514. (B, BI, O).
Eragrostis unioloides (Retz.) Nees ex Steud. Bor 515. (B, BI, O).
Eragrostis viscosa Trin. Bor 515. (B, BI).
Eragrostis zeylanica Nees et Mey. Bor 515. (B, BI).
Leptochloa chinensis (Linn.) Nees. Bor 516. (B, BI, O).
Leptochloa panicea (Retz.) Ohwi. Bor 517. (B, BI, O).
Myriostachya wightiana (Nees ex Steud.) Hook. f. var. *wightiana*. Bor 518. (B).
Neyraudia reynaudiana (Kunth) Keng ex Hitchc. Bor 518. (B, Bi).
Tripogon bromoides Roem. et Schult. Bor 521. (Bi, O).
Tripogon capillatus Jaub. et Spach. Bor 521. (BI, O).
Tripogon filiformis Nees ex Steud. Bor 521. (B).
Tripogon jacquemontii Stapf. Bor 522. (Bi, O).
Tripogon roxburghianus (Steud.) Bhide. Bor 524. (O).

Tribe: FESTUCEAE

Dactylis glomerata Linn. Bor 530. (B).
Festuca cumminsii Stapf. Bor 538. (B).
Festuca leptopogon Stapf. Bor 538. (B).
Festuca ovina Linn. Bor 539. (B).
Festuca polycolea Stapf. Bor 540. (B).
Festuca rubra Linn. Bor 540. (B).
Festuca undata Stapf. Bor 542. (B).
Festuca valesiaca Schleich. ex Gaud. Bor 542. (B).
Lolium multiflorum Lam. Bor 545. (B).
Lolium perenne Linn. Bor 545. (B, Bi).
Lolium temulentum Linn. Bor 546. (Bi).
Poa alpina Linn. Bor 555. (B).
Poa annua Linn. Bor 555. (B).
Poa khasiana Stapf. Bor 557. (B).
Poa ludens Stewart. Bor 558. (B).
Poa nemoralis Linn. Bor 558. (B).
Poa pagophila Bor. Bor 558. (B).
Poa pratensis Linn. Bor 559. (B).
Poa sikkimensis Bor. Bor 560. (B).
Poa stewartiana Bor. Bor 561. (B).
Poa supina Schrad. Bor 561. (B).
Poa tibetica Munro ex Stapf. Bor 561. (B).
Poa trivialis Linn. Bor 561. (B).

Tribe: GARNOTIEAE

Garnotia stricta Brongn. Bor 569. (B, BI, O).

Tribe: Glycerieae

Glyceria tonglensis C. B. Clarke. Bor 571. (B).

Tribe: Isachneae

Coelachne simpliciuscula (Wight et Arn.) Munro ex Benth. Bor 576. (B, BI, O).
Isachne albens Trin. Bor 579. (B, Bi, O).
Isachne dispar Trin. Bor 580. (Bi, O).
Isachne elegans Dalzell ex Hook. f. Bor 580. (Bi, O).
Isachne globosa (Thunb.) O. Ktze. Bor 580. (B, BI).
Isachne himalaica Hook. f. Bor 581. (B).
Isachne miliacea Roth. Bor 582. (B, BI).
Isachne sikkimensis Bor. Bor 582. (B).

Tribe: Oryzeae

Hygroryza aristata (Retz.) Nees ex Wight et Arn. Bor 597. (B, BI).
Leersia hexandra Swartz. Bor 599. (B, Bi, O).
Oryza coarctata Roxb. Bor 604. (B).
Oryza jeyporensis Govinda. et Krishna. Bor 606. (O).
Oryza meyeriana (Zoll. et Mor. ex Steud.) Baill. Bor 604. (B, BI, O).
Oryza minuta J. S. Presl ex C. B. Presl. Bor 605. (B, BI).
Oryza rufipogon Griff. Bor 605. (B).
Oryza sativa Linn. Bor 605. (B, Bi, O).

Tribe: Perotideae

Perotis hordeiformis Nees apud Hook. et Arn. Bor 611. (B).
Perotis indica (Linn.) O. Ktze. Bor 611. (B, BI, O).

Tribe: Phalarideae

Phalaris arundinacea Linn. Bor 615. (B).
Phalaris minor Retz. Bor 616. (B, Bi).

Tribe: Sporoboleae

Crypsis schoenoides (Linn.) Lamk. Bor 622. (BI).
Sporobolus coromandelianus (Retz.) Kunth. Bor 627. (B, Bi).
Sporobolus diander (Retz.) Beauv. Bor 629. (B, BI, O).
Sporobolus fertilis (Steud.) Clayton. Bor 630. (B, BI).
Sporobolus piliferus (Trin.) Kunth. Bor 632. (B, Bi, O).
Sporobolus tetragonus Br. Bor 633. (BI).
Sporobolus tremulus (Willd.) Kunth. Bor 633. (B, Bi, O).
Sporobolus virginicus (Linn.) Kunth. Bor 634. (B).
Sporobolus wallichii Munro ex Trin. Bor 634. (BI).

Tribe: Stipeae

Oryzopsis aequiglumis Duthie. Bor 639. (B).
Stipa mongholica Turcz. ex Trin. Bor 645. (B).
Stipa purpurea Griseb. Bor 645. (B).
Stipa roylei (Nees) Mez. Bor 646. (B).

Tribe: Thysanolaeneae

Thysanolaena maxima (Roxb.) O. Ktze. Bor 650. (B, BI, O).

Tribe: Triticeae

Agropyron canaliculatum Nevski. Bor 659. (B).
Agropyron semicostatum Nees ex Steud. Bor 665. (B).
Agropyron thoroldianum Oliver. Bor 667. (B).
Elymus dasystachys Trin. Bor 669. (B).
Elymus nutans Griseb. Bor 670. (B).
Hordeum vulgare Linn. Bor 677. (C).
Triticum aestivum Linn. Bor 679. (C).

Tribe: Zoysieae

Tragus biflorus Schult. Bor 682. (B, Bi, O).
Zoysia matrella (Linn.) Merr. Bor 684. (B, O).

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New Descriptions

Reptilia from Bhutan with description of a new species of *Calotes* Rafinesque[1]

S. Biswas
Zoological Survey of India, Calcutta

There is little information on the Reptilian fauna of Bhutan because that country seldom, if ever, permitted Zoological Collection to be made there. Recently, however, this policy was changed and the Zoological Survey of India was allowed to undertake faunistic survey in Bhutan. While collecting bird, Dr. B. Biswas obtained five examples of reptiles during 1966 and 1967. The collection though small, is in teresting indeed, inasmuch as it had a new species of the genus *Calotes*.

Family: Agamidae

Japalura variegata Gray

1853. *Japalura variegata* Gray, Ann. Mag. Nat. Hist. (2) xii, p. 388.
Material: 1 ex., Batase (*c.* 1500 m), Central Bhutan, 19 Nov. 1967.

Remarks: The nuchal crest low, two folds of skin run by the sides of nuchal and dorsal crest; a strong oblique fold in front of the shoulder extending nearer throat. White stripes along the sides of neck narrow and faint; upper lip white marked with brown specks; light and dark faint annuli on tail; lower part of body white with brown bloches, prominent on thigh and legs. Series of chevron shaped stripes on the back corresponding the enlarged scales absent.

Measurement: Snout to vent 33 mm, tail 83 mm.

Calotes versicolor (Daudin)

1802. *Agama versicolor* Daudin, Hist. Nat. Rept. iii, p. 395, pl. xlix.
Material: 1 ex. Samdrup Jongkhar (*c.* 300 m), East Bhutan; 14 May, 1966.
Measurement: Length—snout to vent 93 mm, tail 243 mm.

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[1] Accepted May 1973.

Calotes bhutanensis sp. nov.

Material: Holotype: Zoological Survey of India, Reg. No. 22480; Janjurmane (*c*. 1525 m), Central Bhutan; collected by B. Biswas; 7 Dec., 1967; Deposited in Zoological Survey of India.

Description: Length of head just less than one and half of its breadth; snout a little longer than the orbit; fore-head little concave; cheeks slightly swollen, upper optic region more convex and parietal region more or less straight when compared with *Calotes versicolor*. Upper head-scales unequal, not keeled but feebly rugosed; two well separated spines on each side of the back of the head above tympanum; canthus rostralis prominent and sharp; superciliary edge less sharp than *C. versicolor* and eye bulges out of the edge; breadth between two anterior eye corners more than the eye corner to the end of the snout, thus length of snout being short gives the appearance of snub-nosed or short snouted; 12 upper and 11 lower labials; diameter or tympanum less than half of the orbit; body compressed; dorsal scales keeled, roundly pointed backwards and upwards, almost equal to or slightly larger than the ventral scales which are strongly keeled and mucronate, 50 scales round the middle of body; no gular pouch but the throat inflatable, with some smaller and narrower scales in the middle than that of its surrounding; no fold or groove in front of the shoulder; nuchal and dorsal crests composed of angularly pointed scales (not lanciform or falciform) and decreasing gradually from behind neck towards posterior part of body; a row of scales composed of eight erect scales on sides of neck; limbs moderate, third and fourth fingers nearly equal, fourth toe longer than third.

Coloration in spirit: White above with black, transverse, wavy or variegated patches on the back and sides of body, dorsally these black patches together give the appearance of wavy lines. Four lines or stripes from sides of head on or below neck, 1st from sides of temporal region meet on the neck like V, 2nd from above tympanum on neck, 3rd from just below eye through tympanum on the side of neck, 4th from upper jaw to the arm. From lower jaw four lines run on the throat and chin. Ventral side white with longitudinal faint blackish lines, but one line along the middle of ventral side up to base of tail more prominent, then continues under the tail being interrupted at regular intervals.

Remarks: In respect of certain characters such as the scales on the sides of body pointing backward and upward and the size of the head, this species may be placed in the *Calotes versicolor* group of species. It appears close to *C. versicolor* (Daudin) in having no fold or pit in front of the shoulder and in the presence of two separated spines above the tympanum. Another species of the *versicolor* group, *C. maria* Gray differs from *C. bhutanensis* in having no spine above tympanum and

possessing two parallel rows of compressed scales above tympanum. The new species differs from *C. versicolor* and other species of the group in having a row of erect scales on the sides of the neck, short snout, less swollen cheecks, convex optic region and the characteristic coloration.

A comparative table of measurements of body parts of *C. bhutanensis* and 7 specimens of *C. versicolor* from Darjeeling district in Eastern Himalaya is given here (Table 1). Further, a key differentiating the new species from other two related species is given below:

TABLE 1

	Measurements of *C. bhutanensis*	Measurements of 7 *C. versicolor* specimens from the E. Himalaya
Reg. Nos.	Holotype 22480	15640, 15219, 15222, 17794, 4585, 21038 (2 exs.)
Length of body (tip of the snout to vent	61	50-87 (av. 67.7)
Length of tail (vent to tip)	135	115-235 (av. 179.8)
Head length (tip of the snout to tympanum)	14.6	12-25 (av. 18.6)
Head breadth of temporal region	10	9-16 (av. 11.5)
Diameters of eye	4	3-5 (av. 4)
Diameters of tympanum	2	2-4 (av. 2.7)
Length of fore limb	31	25-45 (av. 34)
Length of hind limb	47	42-74 (av. 57.8)
Snout to arm	25	16-42 (av. 30.4)
Axilla to groin	30	24-52 (av. 37.4)
Distance between two anterior corners of eyes	7.6	5.5-10 (av. 7.4)
Distance between tip of snout to anterior corner of eye	5.2	5-10 (av. 7)
Body length: tail	Less	More
Ant. corners of eyes: distance between anterior eye corner to snout	Longer	Almost equal
Head length: head breadth	Less	More

KEY FOR THE IDETIFICATION OF *Calotes bhutanensis* AND ITS ALLIED SPECIES:

II. Scales on the sides of the body pointing backward and upward.
  (a) Two separated spines above the tympanum.
    1. No erect scale row by the side of the neck, snout long, colour brown .... *C. versicolor*
    2. One erect scale row by the sides of the neck, short snout, black variegated patches on the body .... *C. bhutanensis*
  (b) No spine above tympanum, two parallel rows of compressed scales above tympanum, colour green .... *C. maria*

Family COLUBRIDAE
Amphiesma stolatus (Linnaeus)

1758. *Coluber stolatus* Linnaeus, *Syst. Nat.* 10th ed., p. 219.

Material: 1 ex., Samdrup Jongkhar (300 m), East Bhutan; 15 May, 1966.

Remarks: Body deep brownish, black cross bars intersected by two dorsolateral whitish stripes, at their point of intersection white dots prominent, in posterior part of body these stripes more prominent and cross bars gradually fade being confined as specks of black. Three bars from eye to upper jaw, one in front eye another obliquely behind and 3rd from lower edge of eye to the jaw.

Measurement and count: Length snout to vent 702 mm, tail 122 mm; ventral – 152, subcaudal – 56.

Family ELAPIDAE
Ophiophagus hannah (Cantor)

1836. *Hamadryas hannah* Cantor, *Asiat. Research.* xix, p. 187, pls. 10-11.

Material: 1 ex., Rongtong (*c.* 2042 m), Manas Valley, East Bhutan; 2 April 1966.

Remarks: The colour scheme of the present specimen generally conforms to that of the adult specimens, but some additional observations on it may be mentioned here:

44 yellowish bars edged with black present on the body, anterior body scales brown with black restricted to the upper and anterior border of the scales; on the posterior part of the body and tail black predominates and gives a general blackish body colour.

Measurement and count: Length snout to vent 25 cm, tail 41 cm; ventral – 234, subcaudal – 90.

A new species of Coreidae (Heteroptera) from Bombay, India[1]

MOHAN DHOTRE
(*With two plates*)

INTRODUCTION

The family Coreidae (Heteroptera), includes a most remarkable group of insects that have a dry leaf-like appearance and have their pronotum and abdomen expanded and foliacious with spinose margins.

Three species, [2]*Craspedum indicum* West. (= *Tongorma indicum*) collector Boys, locality India; *C. campbelli* Dist. (= *T. campbelli*) and *C. butleri* Dist. (= *T. butleri*) from Chikkaballapura, Karnataka, are known from India. One species *C. burmanicum* Dist. (= *T. burmanicum*), has been described from Burma (Upper Burma, Mandalay).

In April 1974, a specimen of *Tongorma* was obtained from the forest of the Borivli National Park which differs significantly from all other species so far described and is treated here as new.

Tongorma griphus sp. nov.

Type ♀, B.N.H.S. Collection Reg. No. Tys. 281
Collected at Borivli National Park, Bombay City, Maharashtra, in April 1974.
Collector: B.N.H.S. field party.

DESCRIPTION

Based on a single female specimen obtained.

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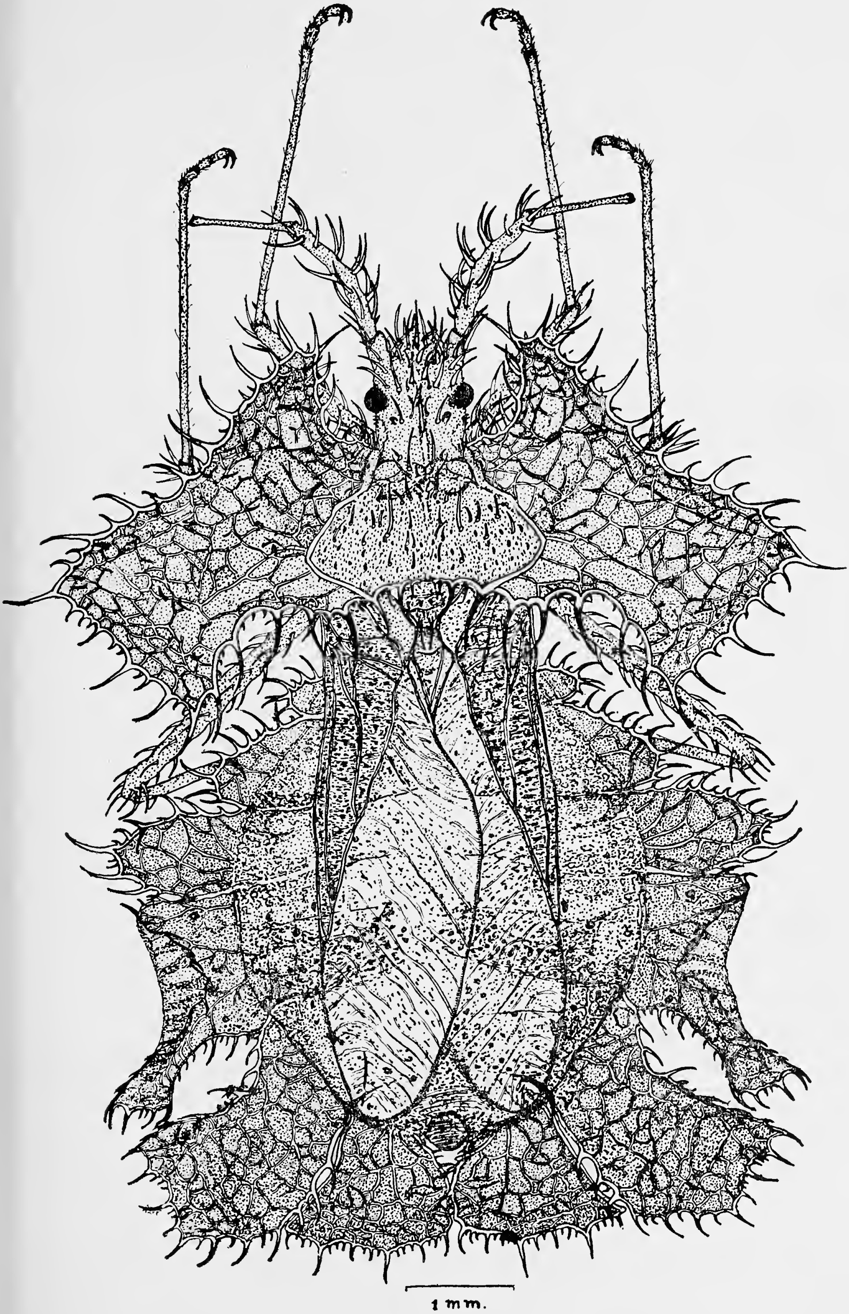
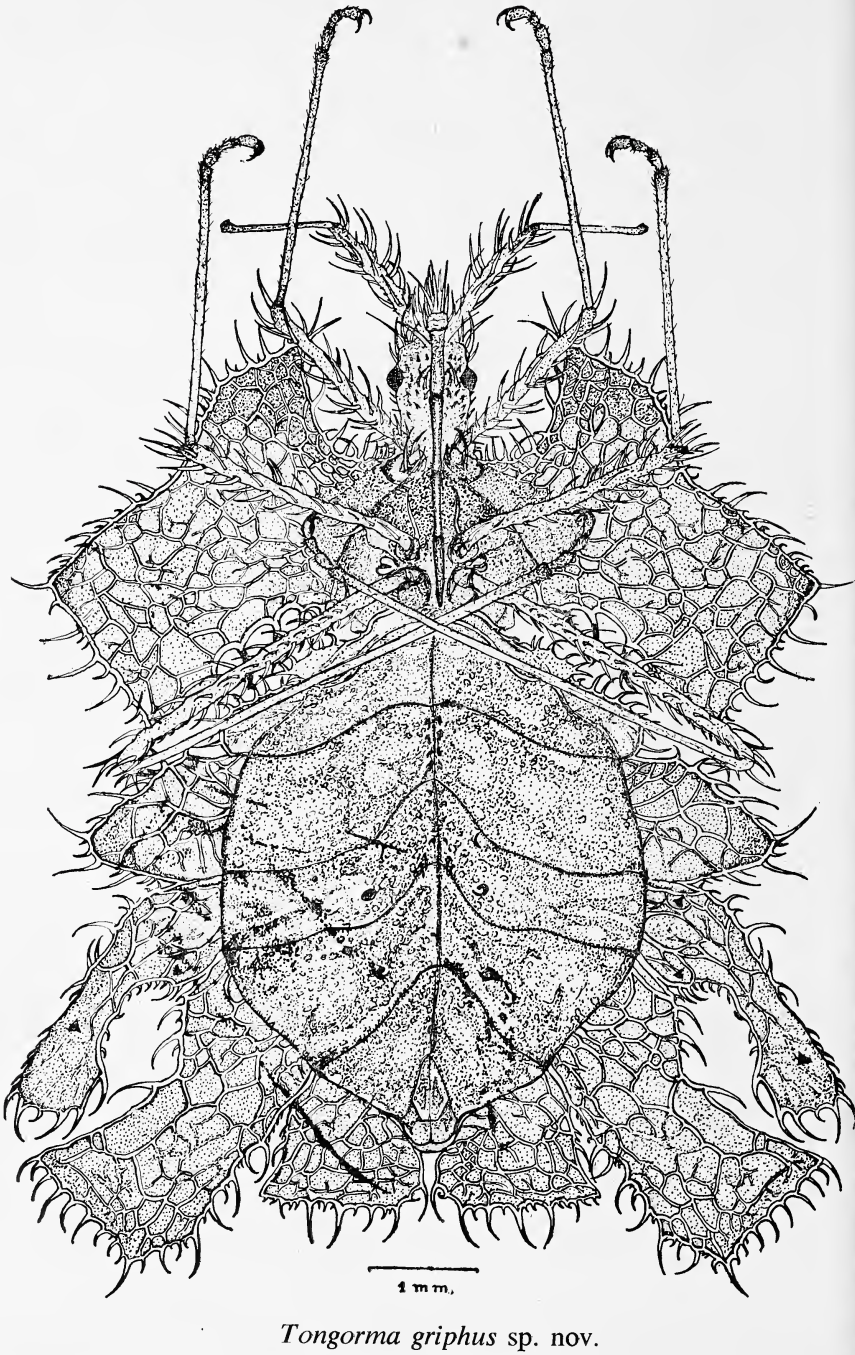
[1] Accepted March 1975.

[2] According to Dr. W. R. Dolling (personal communication), "The genus *Craspedum* Amyot and Serville (type-species *Phyllomorpha* Latreille) is preoccupied by *Craspedum* Rambur (type-species *laciniatum* Villers). Kirkaldy (1900) in Entomologist *33*:242 proposed *Tongorma* (type-species *Phyllomorpha*) as a replacement name for Amyot and Serville's genus. All three of Distant's species and *indicum* (Westwood) belong therefore to *Tongorma* Kirkaldy along with the African species."



Tongorma griphus sp. nov.
Dorsal view.



Tongorma griphus sp. nov.
Ventral view.

Head

Antennae. Only basal two joints remain. Basal joint longer than the second and covered with thick long curved spines. Antennae situated at the level of eyes.

Dorsal, and especially anterior side of the head, covered with long spines. Head as long as basal antennal segment. Ocellii two in number.

Rostrum with first joint extending considerably behind the eyes; second joint longer that the third. Apex of the rostrum reaching and slightly extending behind the posterior coxae. Eyes reddish.

Thorax. Pronotum well expanded, ampliated laterally with anterior and posterior angles. Anterior angle reaching base of the antenna. Posterior margin sinuate. Entire margin and anterior-dorsal and posterior-dorsal surfaces covered with long spines. Small spines are intermingled with long marginal ones. Pronotum slightly darker than abdomen.

Abdomen. Abdomen rounded with six abdominal segmental lobes. Fourth and fifth lobes well expanded, laterally ampliated, producing angles. Fourth lobe partially upturned. Posterior margin of the sixth lobe truncated. First lobe smallest, rounded. Margin of all lobes with long spines, small spines intermingled with long ones. Spines of first and second lobes black in colour.

A column of very small spines on either side of the central line of abdomen. Abdominal spiracles black. Abdomen with areas of black dots. Veins of the expanded pronotum and abdominal lobes are very distinct forming a network.

Legs: Femur, with long curved spines; tarsi three jointed. Tibae and tarsi ochraceous.

Wings: Transparent.

Colour: Fulvescent, with areas of black dots.

Length: 7.5 mm.

Habits: The specimen was obtained from among dried vegetation in a tropical moist deciduous forest. The form of the insect was singularly effective as camouflauge and the insect would not have been noticed if it had not moved. The resemblance to the dried leaves amongst which it was found was most striking. No information is available on the habits of Oriental species. According to Pesson (1959) the female of an European species attaches her eggs to the back of the male who carries them until they hatch.

Discussion:

Distant (1902), listed, in the Fauna of British India, the species *Craspedum indicum* West. (= *Tongorma indicum*) with six abdominal lobes. Subsequently, he (1908; 1918) described three more species of *Craspedum* (= *Tongorma*) all having four abdominal lobes. Accord-

ing to Dr. W. R. Dolling (personal communication), Distant in his description of the three species overlooked, the first lobe and failed to observe that the last two lobes are separate. Dr. Dolling has examined Distant's types and all have six lobes.

Although, the species *Tongorma griphus* closely resembles *Tongorma indicum* (West), it can be distinguished from the latter by the veins on the expanded pronotum and abdominal segmental lobes which are very distinct and can be traced up to their tips. The new species does stand somewhat apart from all other species of the genus (including *indicum*) in having the disc of the pronotum sharply demarcated from the lobes.

Tongorma griphus sp. nov. is distinguished from all other Indian species by:

(a) a sharply demarcated pronotal disc.
(b) more angulate pronotal and abdominal lobes.
(c) distinct veins on the pronotal and abdominal lobes.

Acknowledgements

I am deeply indebted to Dr. W. R. Dolling, British Museum, for critically examining the manuscript and for his comments and permission to quote therefrom.

I am grateful to Mr. Ronald Crombie, U.S. National Museum for the xerox copy of Amyot and Serville's description of genus *Craspedum* and to Miss Ira Reuben for the translation from French of the generic description.

I am grateful to Mr. J. C. Daniel, Curator, Bombay Natural History Society, for having given me every facility and advice.

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A new nasute termite from South India (Isoptera: Termitidae: Nasutitermitinae)[1]

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(*With two plates*)

While examining the unidentified termite collections from Tamil Nadu, I came across a vial, containing several soldiers and workers of a new species, which also proved to be a new genus (*vide infra* under affinities).

Alstonitermes[2] gen. nov.

Type-species: *Alstonitermes flavescens* sp. nov.

(a) *Diagnostic characters*:

1—IMAGO: Unknown.

2. SOLDIER:

General: Head-capsule flavescent; rostrum pale reddish brown, darker basally.

Head: Head-capsule ampulaceous; distinctly wider than long (without rostrum); not constricted behind the antennae; sparsely pilose with small hairs and two long hairs one on either side on middle of head-capsule; rostrum short, conical, with a few hairs at the tip. *Antennae*: With 13-segments. *Mandibles*: Vestigial; outer margins without spinous processes. *Postmentum*: Club shaped; strongly convex laterally.

Thorax: *Pronotum*: Small, saddle shaped and sparsely hairy. *Mesonotum*: Narrower than pronotum. *Metanotum*: Broader than pronotum. *Legs*: Unusually elongated, femora slender; tibial spurs 2:2:2; tarsi 4-segmented.

Abdomen: Subglobular. Cerci 2-segmented.

3. WORKER:

General: Head-capsule dark rusty brown, frons paler; antennae

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[1] Accepted April 1975.

[2] Named after the host, genus *Alstonia*.

pale yellow, becoming yellowish distally; legs and abdomen whitish yellow.

Head: Head-capsule subsquarish; wider than long; epicranial suture indistinct. *Fontanelle Plate*: Small, oval and submedially placed. *Antennae*: With 14-segments. *Clypeus*: Postclypeus swollen; length less than half its width. Anteclypeus trapezoid, translucent. *Mandibles*: Left mandible with an apical, two marginal teeth and a basal projection; apical subequal to 1st marginal tooth; angle between the apical and the 1st marginal very acute (*c.* 50°); 1st marginal large and subtriangular; 2nd marginal small, triangular and widely separated from the 1st by a large wide sinuate border; basal projection large and broadly rounded. Right mandible also with an apical, two marginal teeth and a molar plate; apical acute, subequal to 1st marginal; 1st marginal triangular, with subequal anterior and posterior borders; 2nd marginal small, subtriangular; angle between the 1st and 2nd marginals deeply acute; its posterior border straight and twice its anterior border; molar plate with inner edge weakly concave, bifurcated.

Thorax: *Pronotum*: Saddle shaped; anterior lobe strongly upturned; anterior margin weakly to deeply notched in the middle. *Mesonotum*: and *Metanotum*: Broader than pronotum. *Legs*: Long, slender; tibial spurs 2:2:2; tarsi 4-segmented.

Abdomen: Subglobular. Cerci 2-segmented.

(b) *Affinities*:

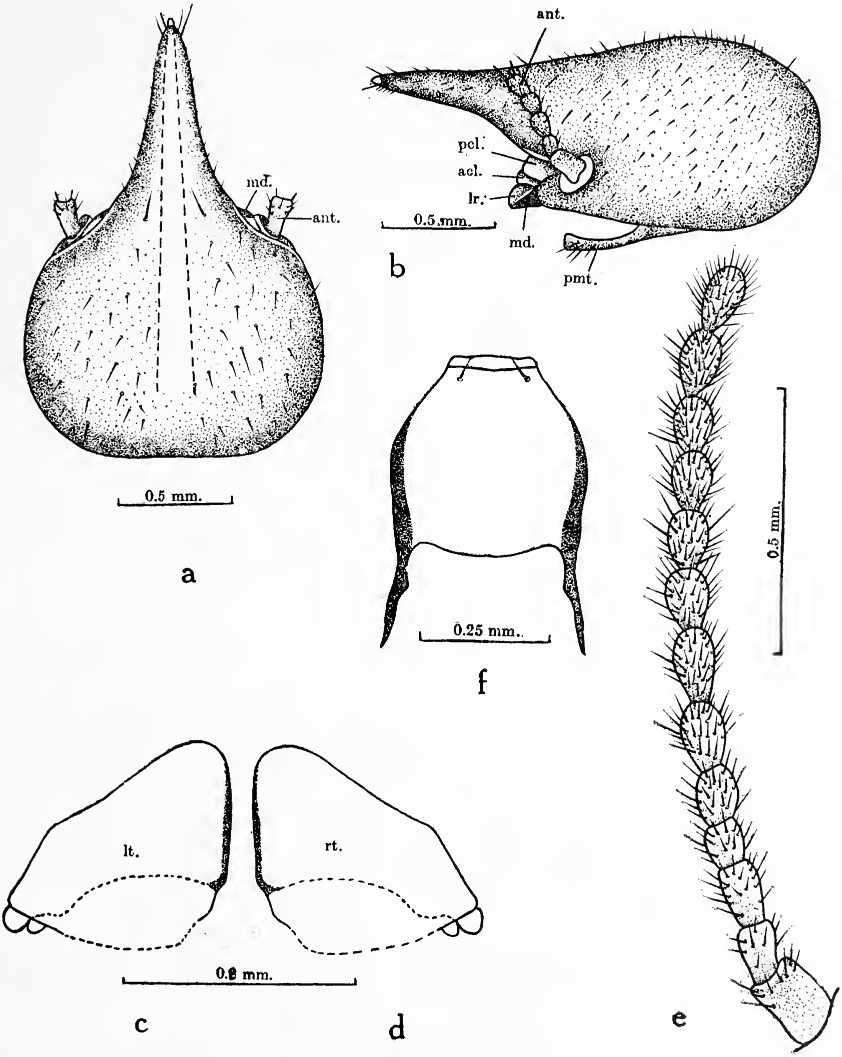
The study of worker mandibles of this new genus leaves no doubt about its phylogenetic placement in the *paracornitermes* branch of the sub-family Nasutitermitinae, in which the imago-worker mandibles are characterised by (i) the posterior margin of the 1st marginal tooth of left mandible being undulating; (ii) the apical tooth being not much enlarged, without atrophy, degeneration or ultimate disappearance of any marginal tooth and (iii) the left mandibular index being generally low.

In these characters, it comes close to genus *Emersonitermes* Mathur et Sen-Sarma, however it differs from it as follows:

Soldier: (i) Head-capsule ampule shaped, distinctly broader than long (*vs.* pear shaped, distinctly longer than broad). (ii) Antennae 13-segmented (*vs.* 14-segmented). (iii) Rostrum short and conical (*vs.* long and awl shaped; rostrum—head index 0.52-0.60 *vs.* 0.86-0.89).

Worker: (i) Left mandibular index is distinctly lower (0.50 *vs.* 0.57). (ii) The angle between the 1st and 2nd marginals of right mandible distinctly acute (*vs.* obtuse in *Emersonitermes*); 2nd marginal more prominent and triangular; its posterior border straight. (iii) Antennae 14-segmented (*vs.* 13-segmented) and (iv) postclypeus less than half its width (*vs.* half its width).

Thakur: *Alstonitermes* gen. nov.

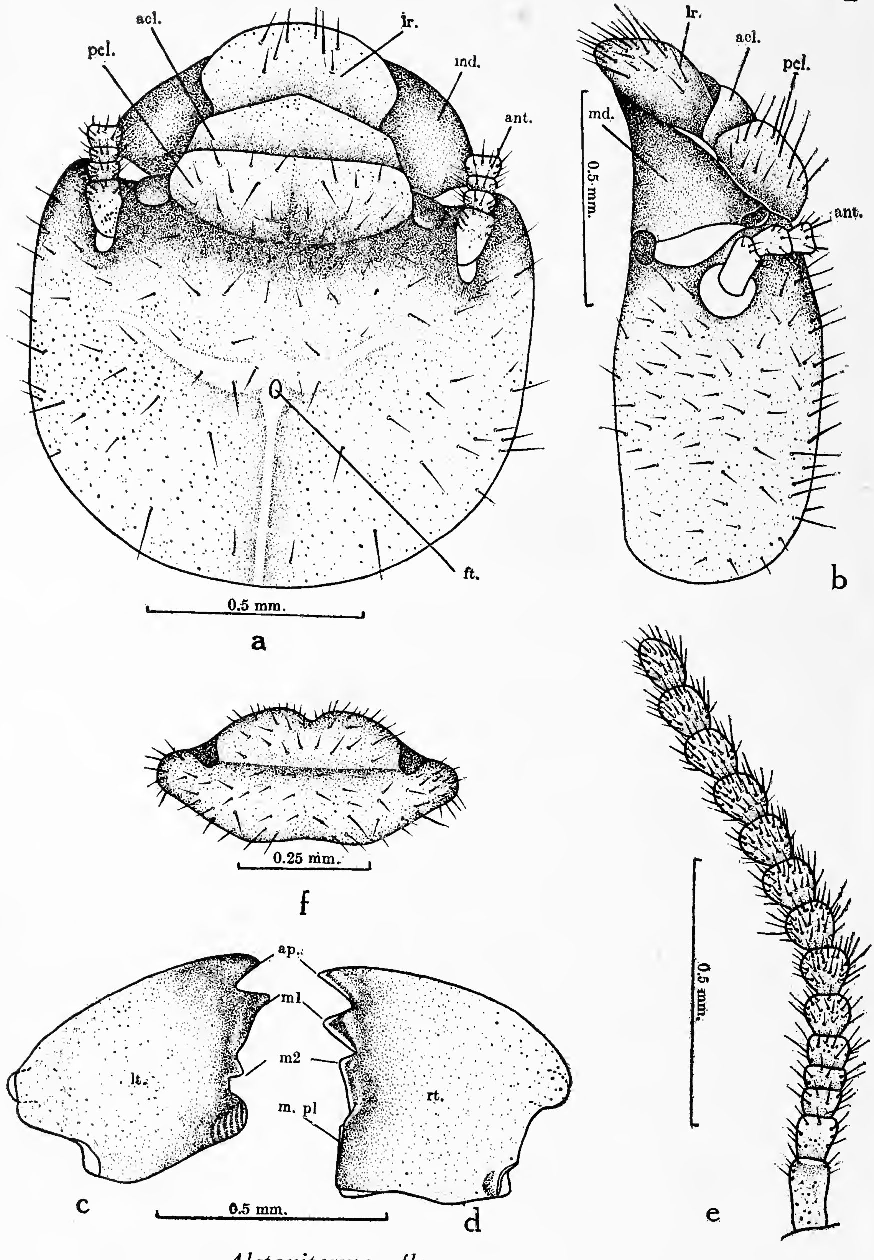


Alstonitermes flavescens sp. nov.

Caste: *Soldier*. (*a*) Head, Dorsal view; (*b*) Head, side view; (*c*) Left mandible; (*d*) Right mandible; (*e*) Left antenna; (*f*) Postmentum.

acl.—anteclypeus; ant.—antenna; lr.—labrum; lt.—left; md.—mandibles; pmt.—postmentum; rt.—right.

PLATE 2



Alstonitermes flavescens sp. nov.

Caste: *Worker*. (*a*) Head, dorsal view; (*b*) Head, side view; (*c*) Left mandible; (*d*) Right mandible; (*e*) Right antenna; (*f*) Pronotum, dorsal view. acl.—anteclypeus; ant.—antenna; ap.—apical tooth of mandible; ft.—fontanelle; lr.—labrum; lt.—left; md.—mandibles; ml-m2.—1st-2nd marginal tooth of mandible; m.pl.—molar plate; pcl.—postclypeus; rt.—right.

Alstonitermes flavescens sp. nov.

(a) *Material*:

One vial (M 15/ 11-xii-70), with several soldiers and workers from Kareeyan Shola forest, Top Slip, South Coimbatore Forest Division, Tamil Nadu, coll. M. L. Thakur, 11.xii.1970. *Ex. Alstonia scholaris.*

(b) *Description*:

1—IMAGO: Unknown.

2. SOLDIER: (Plate 1; Table 1).

General: Head-capsule creamy yellow, with a large elliptical whitish yellow portion near the posterior end of head-capsule; frons and anterior margin of pronotum dark rusty brown; rostrum reddish brown, slightly paler apically but darker basally; antennae yellowish brown, paler than rostrum but darker than head-capsule; rest of the body-parts whitish yellow; tibia darker than femora. Head-capsule and pronotum with scattered short hairs, body thickly pilose with long and short hairs.

Head: Head-capsule ampule shaped, distinctly wider than long (without rostrum); greatly swollen in the posterior half, gradually sloping infront; sides bulged out, not constricted behind the antennae; posterior margin depressed, almost straight in the middle. *Rostrum*: Short, conical, broader at base; with long hairs at tip. *Fontanelle*: Fontanelle gland and fontanelle tube indistinct. *Antennae*: Not markedly elongated; 13-segmented, pilose, pilosity increasing distally; segment 2 shorter than 3 but longer than 4; 3 almost twice as long as 4; 4th shortest; 5 longer than 6; 6-12 club shaped, distal segments becoming shorter; last ovate, subequal to penultimate. *Clypeus*: Postclypeus not clearly demarcated. Anteclypeus sugtrapezoid and whitish. *Labrum*: Dome shaped; broader than long, apilose. *Mandibles*: Vestigial, no spinous processes on outer margins; molar area brownish, substraight.

Thorax: *Pronotum*: Saddle shaped, much narrower than head-width (head—pronotum width index 0.38-0.46); anterior lobe weakly upturned; anterior margin semicircular, with an imperceptable median depression; posterior margin substraight. *Mesonotum*: Narrower than pronotum; posterior margin substraight. *Metanotum*: Broader than pronotum; posterior margin weakly convex. *Legs*: Unusually long; tibial spurs 2:2:2; tarsi 4-segmented.

Abdomen: Subglobular, densely covered with short hairs. Cerci 2-segmented; length *c*. 0.08 mm.

3. WORKER: (Plate 2; Table 2).

General: Head-capsule dark rusty brown, frons paler; labrum brownish; postclypeus and antennae pale yellow, becoming yellowish distally; legs and abdomen whitish yellow. Head-capsule sparsely, body densely hairy. Total body-length *c*. 4.00-4.50 mm.

TABLE 1

BODY-MEASUREMENTS (IN MM) AND INDICES OF 10 SOLDIERS OF *Alstonitermes flavescens* SP. NOV.

Body-parts	Range	Mean	Holotype
I-*General*			
1. Total body-length *c.*	4.00-4.50	4.30	4.40
II-*Head*			
2. Head-length with rostrum	1.75-1.88	1.83	1.88
3. Head-length without rostrum	1.15-1.20	1.17	1.20
4. Length of rostrum	0.60-0.70	0.67	0.68
5. Maximum width of head	1.20-1.25	1.23	1.25
6. Height of head	0.75-0.85	0.79	0.80
7. Head-index I. (width/length of head)	1.01-1.08	1.04	1.04
8. Head-index II. (height/width of head)	0.60-0.68	0.64	0.64
9. Head-index III. (height/length of head)	0.63-0.70	0.68	0.66
10. Rostrum-head index	0.52-0.60	0.57	0.57
III-*Thorax*			
11. Length of pronotum	0.20-0.25	0.24	0.25
12. Maximum width of pronotum	0.48-0.55	0.54	0.48
13. Pronotum-head width index	0.38-0.46	0.43	0.38
14. Pronotum index	0.37-0.52	0.43	0.52

Head: Head-capsule subsquarish, broader than long; sides subparallel, weakly converging posteriorly to roundish posterior margin; frons weakly sloping infront; epicranial suture indistinct. *Fontanelle Plate*: Small, oval and submedially placed. *Antennae*: With 14-segments; segment 2 longer than 3; 3 longer than 4; 4 shortest; 5 shorter than 6; rest progressively increasing in length; last ovate, smaller than penultimate. *Clypeus*: Postclypeus swollen; length less than half its width. Anteclypeus trapezoid, whitish and apilose. *Labrum*: Shoval shaped; broader than long. *Mandibles*: As in the genus.

Thorax: *Pronotum*: Saddle shaped; anterior lobe strongly upturned; anterior margin convex, with weak to deep median notch; posterior margin substraight. *Mesonotum*: Broader than pronotum; posterior margin with a median emargination. *Metanotum*: Broader than pronotum; posterior margin weakly convex. *Legs*: Long, slender; tibial spurs 2:2:2; tarsi 4-segmented.

Abdomen: Subglobular. Cerci 2-segmented; length *c.* 0.08 mm.

(c) TYPE-SPECIMENS:

All the type-specimens from a single source as under "*Material*" are deposited as follows:

1. *Entomological Collection, Forest Research Institute, Dehra Dun* (*U.P., India*).

TABLE 2

BODY-MEASUREMENTS (IN MM) OF 5 WORKERS OF *Alstonitermes flavescens* SP. NOV.

Body-parts	Range	Mean
I-*General*		
1. Total body-length *c.*	4.00-4.50	4.25
II-*Head*		
2. Head-length to tip of labrum	1.25-1.55	1.39
3. Head-length to lateral base of mandibles	0.85-1.20	0.98
4. Maximum width of head	1.05-1.28	1.16
5. Height of head	0.50-0.65	0.59
III-*Thorax*		
6. Length of pronotum	0.20-0.35	0.28
7. Maximum width of pronotum	0.48-0.65	0.54

Holotype: One soldier, from Kareeyan Shola, Top Slip, South Coimbatore Forest Division, Tamil Nadu, coll. M. L. Thakur, 11.xii. 1970.

Morphotype: One worker, from the holotype lot and with the same data.

Paratypes and *Paramorphotypes*: Twenty-four soldiers and thirty eight workers.

2. *National Zoological Collection, Zoological Survey of India, Calcutta.*

One paratype soldier and two paramorphotype workers.

(d) TYPE-LOCALITY:

INDIA: *Tamil Nadu*: Kareeyan Shola Forest, Top Slip, South Coimbatore Forest Division (76.40 E; 10.50 N).

Description of a new species of *Branchinella* Sayce from Sambhar Lake, India (Crustacea-Branchiopoda-Anostraca)[1]

I. C. Baid[2]
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(*With five-text-figures*)

Branchinella sambhariana n. sp. (Anostraca) from Sambhar lake, India has been described. It differs from other species of this lake in having a conspicuous outgrowth with a pointed tip, in having 4-7 branches of a frontal appendage which is smaller than the second antenna, and in lacking a secondary branch on the lobe or protuberance of apical joints.

The present paper records and describes a new species of the genus *Branchinella* found in the Sambhar lake in Rajasthan.

Branchinella sambhariana sp. nov.[3]

(Figs. 1, 2)

Male: Generally resembles *Br. kugenumaensis* Ishikawa, *Br. ornata,* and *Br. biswasi.* The body is broad and thick. The cercopods are of the same length as the last abdominal segment and telson. 1st Ant. are longer than the basal segments of II Ant. II Ant. have short and thick basal segments which are fused with the basal part of the frontal appendages. The inner distal margin of the basal segment of II Ant. gives rise to a conspicuous serrated outgrowth with a pointed tip. The apical segments are longitudinally striated and are without branches. The frontal appendages are smaller than II Ant. Each appendage has 4-7 branches which have a rich armature of spines. The apex of each branch is tipped with two spines (Figs. 1, 2).

II max. resemble those of generic type.

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[1] Accepted October 1973.

[2] *Present address*: Dept. of Zoology, Faculty of Science, University of Benghazi, Benghazi, Libya.

[3] Name after the locality, Sambhar lake.

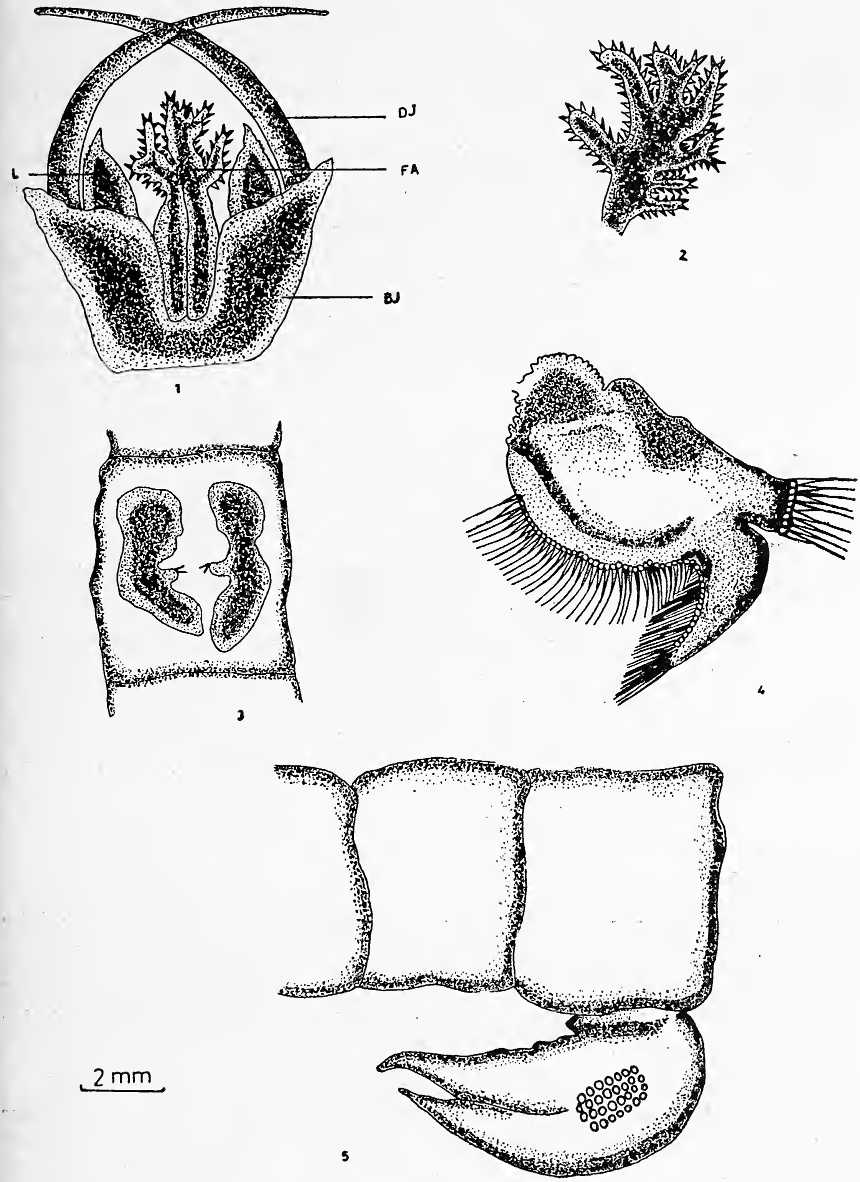

Fig. 1. Second antenna with frontal appendages of *Br. sambhariana* (BJ-Basal Segment; DJ—Distal Segment; FA—Frontal Appendage; L—Conspicuous outgrowth).

Fig. 2. Frontal appendages of *Br. sambhariana* showing armature of spines of branches.

Fig. 3. Male genital organs of *Br. sambhariana* showing protruded penes with a pair of short median spines.

Fig. 4. Toracic appendage of *Br. sambhariana* showing praeepipodite sparsely serrated.

Fig. 5. Ovisac of female *Br. sambhariana.*

Legs have appearance characteristic of the genus. The exopodites are quite long with their tips always reaching beyond the endopodite. The praeepipodites are sparsely serrated and are without any notch (Fig. 4).

Penes have no triangular laminae and are retractable under the surface of the body. Their basal parts which have a pair of short spines near the base, are usually protruded (Fig. 3).

F e m a l e: The shape of the trunk, abdomen and cercopods as in the male. 1st Ant. as long as head. It is linguate and beset with a fair number of sensory hairs. Ovisac is short, reaching only slightly over 4th abdominal segment and bifurcating into two small lobes at its distal end (Fig. 5).

Size:

Male 12 to 22 mm in length.

Female 13 to 26 mm in length.

Types: Holotype (1 ♀ 1 ♂) in the Department of Zoology, University of Rajasthan, Jaipur, India.

Paratypes (many specimens of both sexes) in the Department of Zoology, University of Rajasthan, Jaipur, India and 2 ♀ ♀ 2 ♂ ♂ in British Museum (Natural History), London.

Type-Locality: Sambhar lake, Gudha, Jaipur District, Rajasthan, India, collected by the author on 16th, September, 1957 and on 29th, September 1964.

Remarks:

Br. sambhariana resembles *Br. ornata* and *Br. biswasi* of this lake and *Br. kugenumaensis* Ishikawa reported from East Asia (Ishikawa 1894; Ueno 1926; Hsu 1933; Shen 1933) and from India (Linder 1941). The position of this species in the key of identification (Linder 1941) is as follows:

IA Basal joints of II Ant. with a distal outgrowth set with branches or both.

a. Frontal appendages twice bifid .... *ondogue*

aa. Frontal appendages with three secondary branches on each primary branch .... *kugenumaensis, chaudenui*

IAA Basal joints of II Ant. with a distal serrated outgrowth with a pointed tip and without any branch or spine .... *sambhariana*

Branchinella sambhariana differs from other *Branchinella* species of this lake in having a conspicuous outgrowth with a pointed tip. 4-7 branches of a frontal appendage which is smaller than the second antenna and in lacking a secondary branch on the lobe or protuberance of a apical joints (Table).

TABLE

COMPARISON OF THREE SPECIES OF THE GENUS *Branchinella* FOUND IN THE SAMBHAR LAKE

Br. ornata	*Br. biswasi*	*Br. sambhariana*
II Ant.		
1. Basal segments are united at the base.	1. Basal segments are united at the base.	1. Basal segments are fused at the base with the basal part of the frontal appendages.
2. Finger shaped outgrowth at the base of the apical segment.	2. Finger shaped outgrowth at the base of the apical segment.	2. Conspicuous serrated outgrowth with a pointed tip projects from the inner distal margin of the basal segment.
Frontal appendage		
1. Longer than II Ant.	1. Longer than II Ant.	1. Smaller than II Ant.
2. 5-6 branches with small finger like ventral chitinous formations.	2. 4-8 branches irregularly arranged on each side with scattered spicules more profuse towards the apex.	2. 4-7 branches which have a rich armature of spines. The apex of each appendage is tipped with two spines.
Thoracic appendage		
1. Endites 3-5 of the appendages have 2, 2, 1 anterior setae respectively except the first pair which has respectively 4, 5, and 1 anterior setae.	1. Endites 3-5 of all appendages have 2, 2, 1 anterior setae respectively.	1. Endites 3-5 of all appendages have 2, 2, 1 anterior setae respectively.
2. Praeepipodites with distinct notch about midway along its border.	2. Praeepipodites non-serrated without any notch.	2. Praeepipodites sparsely serrated without any notch.
Penis		
1. It has a triangular outgrowth or lamina with spines on the distal part.	1. It has a triangular lamina with a small wart-shaped armature of spines.	1. Basal part usually protruded; with a pair of short spines near the base.

The genus *Branchinella* has worldwide distribution and its various species are found in fresh as well as in salt water lakes. Nineteen species of *Branchinella* are confined to Australia, one to the eastern and southern parts of Asia (*Br. kugenumaensis*), two to India (*Br. biswasi,* and *Br. sambhariana*), two to Africa (*Br. chaudenui,* and *Br. ondongue*) and one to Europe and Africa north of Sahara (*Br. spinosa*).

I wish to record my deep sense of gratitude to Dr. J. P. Harding, British Museum (Natural History), London and to Dr. F. Linder, Uppsala for examining the material and for their critical comments.

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A new species of spider of the genus *Ctenus* (Family: Ctenidae) from Meghalaya, India[1]

B. K. Tikader

Zoological Survey of India, Western Regional Station, Poona 411 005

(*With five text-figures*)

The spiders of the family Ctenidae were not known from India before 1973. Recently Tikader reported this genus for the first time from Andaman Islands. While examining the spider collection from Meghalaya, India I came across a new species of the genus *Ctenus* which is described here. This family and the genus are being recorded here for the second time from the Indian sub-continent.

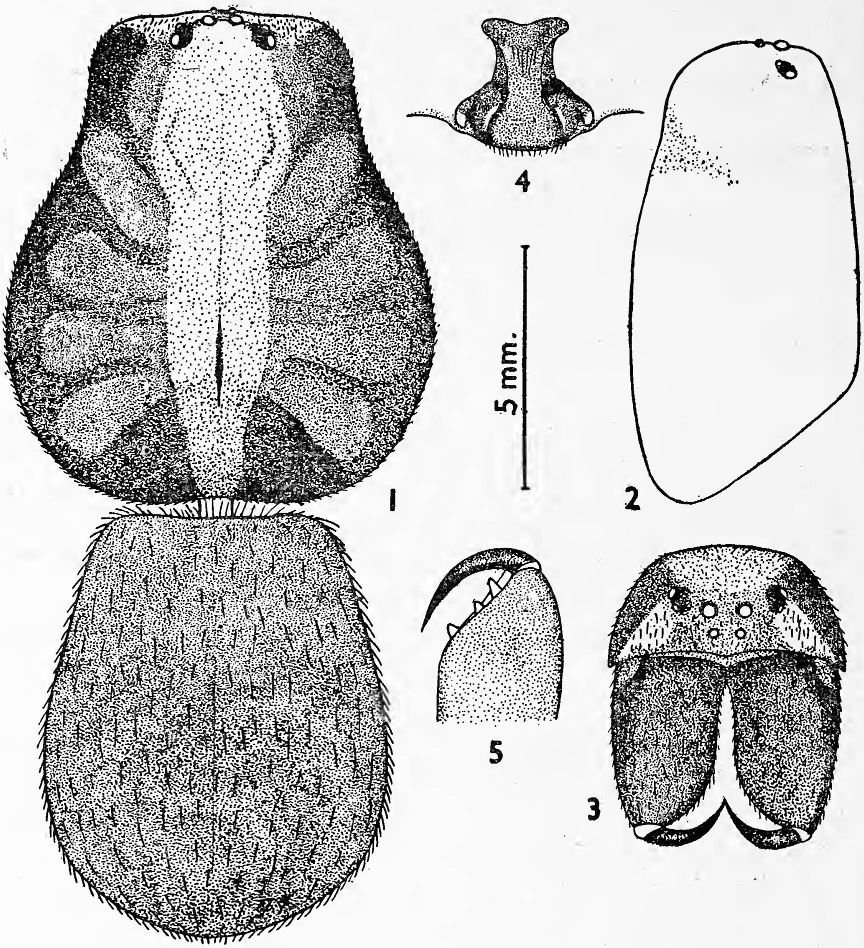
The type specimen will in due course be deposited in the National Zoological Collection, Zoological Survey of India, Calcutta.

Ctenus meghalayaensis sp. nov.

General: Cephalothorax and legs light reddish-brown, abdomen brown. Total length 20.00 mm. Carapace 10.80 mm long, 9.00 mm wide; abdomen 9.00 mm long, 7.00 mm wide.

Cephalothorax: Longer than wide, high and behind with a very steep thoracic declivity as in text-figure 2, clothed with pubescence and few spine-like hairs. Middle of cephalothorax provided with a fovea and a longitudinal, broad light pale band, extending from ocular area to base of cephalothorax. Eyes in three rows, the anterior lateral eyes being situated in front of the posterior median and posterior lateral eyes but slightly closer to the posterior laterals than to the posterior medians as in text-figures 1, 3. Anterior lateral eyes smaller than the anterior medians. Sternum nearly oval, pointed behind, deep brown, clothed with black hairs. Labium longer than wide, and head of maxillae provided with prominent scopulae. Chelicera with three teeth as in text-figure 5. Legs robust and strong, clothed with hairs and spines; tarsus provided with two claws and prominent claw tuft. Metatarsi and tarsi of I and II provided with five and three pairs of ventral spines respectively. Legs formula 1423.

1 Accepted April 1975,



Figs. 1-5. *Ctenus meghalayaensis* sp. nov.

1. Dorsal view of female, legs omitted; 2. Lateral view of cephalothorax, legs omitted; 3. Front view of head, showing arrangement of eyes; 4. Epigyne; 5. Inner view of left chelicera of female.

Abdomen: Longer than wide, wider behind, clothed with fine hairs. Ventral side more deep brown than the dorsal side. Epigyne as in text-figure 4.

Type-specimen: One female in spirit.

Type-locality: Barapani Road side, Shillong, Meghalaya, India. Coll. *A. K. Ghosh*, 17-viii-1973.

This species resembles *Ctenus kapuri* Tikader from Andaman but differs as follows: (i) Ventral side of abdomen uniform deep brown in colour but in *C. kapuri* ventral side of abdomen deep brown in colour and ornamented with conspicuous rows of white dots. (ii) Inner mar-

gin of furrow of chelicera with three teeth but in *C. kapuri* inner margin of furrow of chelicera with five teeth. (iii) Epigyne also structurally different.

ACKNOWLEDGEMENT

I am thankful to Dr. A. K. Ghosh, Zoologist, Eastern Regional Station, Zoological Survey of India, Shillong, Meghalaya, for kindly sending the spider collection for stpdy.

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A new species of spider of the genus *Lutica* (Family Zodariidae) from India[1]

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Zoological Survey of India, Western Regional Station, Poona 411 005

(*With five text-figures*)

The spiders of the family Zodariidae are little known from India. Simon (1905, 1906) and Gravely (1921) have described some species of the family from India. Recently Tikader & Patel (1975) described some new species of the genera *Storena* and *Lutica* from India. This is the second species of *Lutica* described from the Indian sub-continent.

The type specimen will in due course be deposited in the National Zoological Collection, Zoological Survey of India, Calcutta.

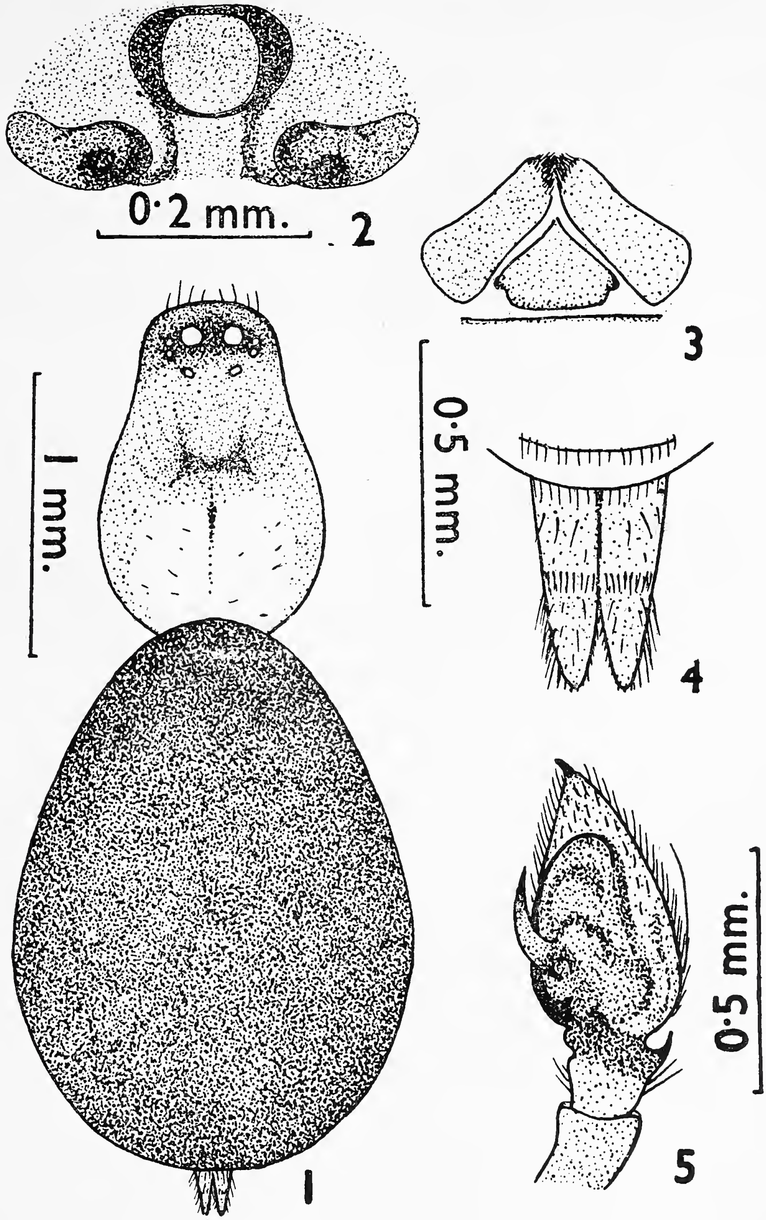
Lutica deccanensis sp. nov.

General: Cephalothorax and legs with brownish red tint and abdomen uniform brownish red in colour. Total length 3.10 mm, Cephalothorax 1.20 mm long, 0.80 mm wide; abdomen 2.00 mm long, 1.50 mm wide.

Cephalothorax: Longer than wide narrowing in front, cephalic region slightly high with rounded margin and provided with light brown patch in the centre as in text-figure 1. Eyes pearly white except anterior medians. Anterior row slightly recurved and anterior median eyes conspicuously larger than others and encircled by deep brown patch. Posterior row strongly procurved and posterior medians away from each other and more nearer to adjacent laterals. Both lateral eyes contiguous and nearly of same size. Legs long and moderately strong, clothed with fine hairs and some clavate hairs. Legs formula 4132. Sternum heart shaped, pointed behind, clothed with fine hairs. Labium and maxillae as in text-figure 3. Male nearly of same colour as female but slightly smaller in size. Male palp as in text-figure 5.

Abdomen: Longer than wide, nearly globular and wider behind the middle; slightly over-lapping on cephalothorax in front. Dorsal side uniform deep brownish red in colour, clothed with fine

[1] Accepted October 1974.



Figs. 1-5. *Lutica deccanensis* sp. nov.
1. Dorsal view of female, legs omitted; 2. Epigyne; 3. Labium and maxillae; 4. Spinnerets; 5. Male palp.

hairs and pubescence. Ventral side uniform pale coloured. The fore pairs of spinnerets are conspicuously long and other two pairs not developed properly as in text-figure 4. Epigyne as in text-figure 2.

Holotype one female, *allotype* one male in spirit.

Type-locality: Vetal Hill, Gokhale Nagar, Poona, Maharashtra, India. Coll. *M. S. Malhotra,* 21-vii-1974.

This species resembles *Lutica bengalensis* Tikader & Patel but is separated as follows: (i) Dorsal side of abdomen uniform brownish red in colour but in *L. bengalensis* dorsal side of abdomen uniform deep brown in colour. (ii) Epigyne and male palp also structurally different.

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A new species of spider of the genus *Plator* Simon (Family: Platoridae) from India[1]

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(*With four text-figures*)

The spiders of the family Platoridae are little known from India. The first species of the genus *Plator* Simon was described from India by Simon (1897) and a second species was described by Tikader (1969). Subsequently two more species were recently described by Tikader & Gajbe (1973, 1975).

While examining the spider collection from High Altitude Zoology Field Station, Zoological Survey of India, Solan, H.P., India, we came across a new species of spider of the genus *Plator*, which is described here. It is the fifth species of the genus *Plator* from India.

The type specimen will in due course be deposited in the National Zoological Collection, Zoological Survey of India, Calcutta.

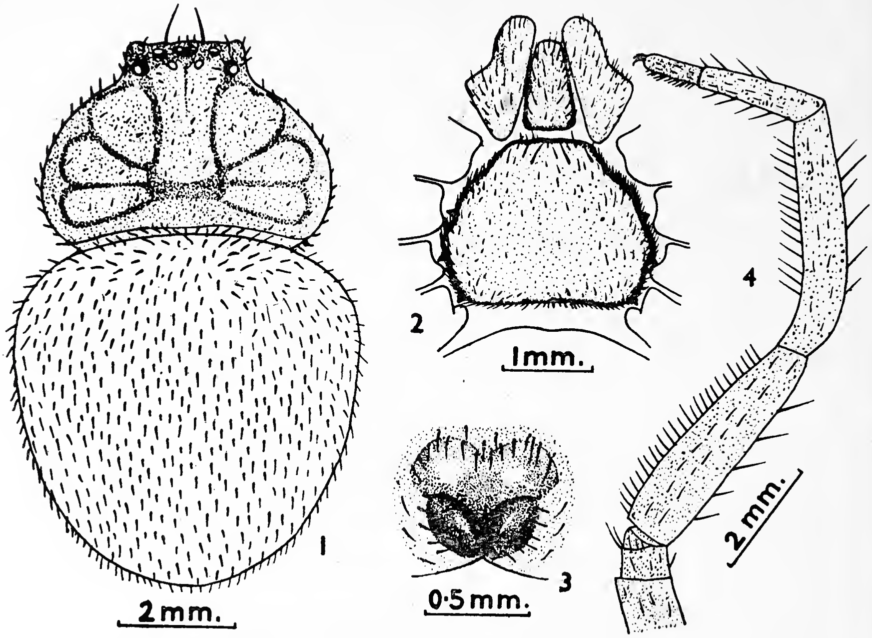
Plator solanensis sp. nov.

General: Cephalothorax and legs reddish brown, abdomen dirty chalk white. Total length 9.00 mm. Carapace 3.10 mm long, 4.80 mm wide; abdomen 5.80 mm long, 5.60 mm wide.

Cephalothorax: Very flat, leaf-like, much wider than long, cephalic region narrow and slightly high, clothed with black short spines. Eyes eight, in two rows, posterior row recurved but anterior row very little recurved. Posterior lateral eyes larger and black but posterior medians smaller and pearly white, bases of eyes encircled by black patch except posterior medians. Labium longer than wide as in text-figure 2. Sternum wider than long, slightly narrow in front, clothed with fine hairs. Legs long and strong, clothed with hairs and spines. Legs I shorter than the rest, II longest, anterior two legs armed with conspicuous erect spiniform bristles as in text-figure 4. Tarsus without scopulae or ungual tufts.

Abdomen: Very flat, leaf-like, nearly round or oval and slightly

[1] Accepted April 1975.



Figs. 1-4. *Plator solanensis* sp. nov.
1. Dorsal view of female, legs omitted; 2. Maxillae and labium; 3. Epigyne; 4. First leg of female.

longer than wide; clothed with fine hairs. Dorsally provided with irregular small markings as in text-figure 1. Ventral side slightly lighter than dorsal and clothed with fine hairs. Epigyne as in text-figure 3.

Holotype female, *paratype* one female in spirit.

Type-locality: Kasauli, Dist. Solan, Himachal Pradesh, India. Coll. *H. P. Agrawal,* 22-xii-1972, *paratype*: Tikkar Sarahan, Dist. Sirmour, Himachal Pradesh, India. Coll. *H. P. Agrawal,* 27-ix-1973.

This species appears to be related to *Plator himalayensis* Tikader & Gajbe, but it is separated as follows: (i) Anterior row of eyes very slightly recurved but in *Plator himalayensis* anterior row of eyes straight. (ii) Posterior median eyes without stalk like structure but in *Plator himalayensis* posterior median eyes with stalk like structure. (iii) Abdomen very slightly longer than wide with white markings but in *Plator himalayensis* abdomen wider than long with irregular minute markings of muscular corrugation and three transverse muscular depressions. (iv) Epigyne also structurally different.

Acknowledgement

We are thankful to Dr. Arun Kumar, Zoologist, Zoological Survey of India, High Altitude Zoology Field Station, Solan, for supplying the spider collection for our study.

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A new record of the family Amaurobiidae (Arachnida : Araneae) from India[1]

B. H. PATEL[2] AND H. K. PATEL[3]

(With a text-figure)

Occurrence of the spider belonging to the family Amaurobiidae with a new species of genus *Amaurobius* Koch is recorded for the first time from India and described in this paper.

INTRODUCTION

In the course of a study of the taxonomy of spiders from different parts of Gujarat during the years 1967-1971 one of us (BHP) came across a spider belonging to the family Amaurobiidae.

In this paper we have recorded and described a new species of the genus *Amaurobius* Koch of the family Amaurobiidae. We have included herein the characters of the family and the genus also for easy identification of the Indian forms, as the family and genus are new records for India.

The type specimen will in due course be deposited in the National Collections of the Zoological Survey of India, Calcutta.

Family AMAUROBIIDAE

Characters: Six or eight eyes; eyes if eight, in two transverse rows, all eyes pale in colour. Chelicerae robust, geniculate at the base anteriorly, bearing scopula. Labium notched basally. Legs moderately to heavily spined, rarely lacking spines. Trichobothria in one or two rows on tibiae, absent on femora. Thoracic groove longitudinal, when present. Cribellum and calamistrum present, usually cribellum divided into two

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[1] Accepted November 1972.

[2] Department of Biology, V. P. Mahavidyalaya, Vallabh Vidyanagar (W. Rly.), Gujarat (India).

[3] Department of Entomology, Institute of Agriculture, Anand (W. Rly.), Gujarat (India).

parts, calamistrum reduced or absent in males of some species. Male with median apophysis in palpal organ. Tarsi possess three claws, without claw tufts or scopulae.

Spiders of average size which resemble in a striking way, members of the family Agelenidae. They differ from the Agelenidae in having a cribellum and a calamistrum. They are distinguished from Dictynidae in having all eyes pale in colour, in the structure of genital organ and the legs with strong spines; in dictynids, only in few cases are the true spines present.

The spiders of this family construct irregular webs consisting of a frame work of plane threads supporting an irregular net-work of the hackled band. Some times the supporting threads radiate from the opening of a retreat with a certain degree of symmetry, giving the web a somewhat regular appearance. Due to the coarser nature of the structure of hackled band, it is easily seen in the webs of *Amaurobius* then in the webs of other genera.

Genus *Amaurobius* Koch

Amaurobius Koch, 1837. *Ueb. Ar. Syst.*, *1*:15.
Ciniflo: Blackwall, 1841. *Trans. Linn. Soc. London* (*Zool.*), *18*:607.
Amauribius: Thorell, 1869. *Niva. Acta R. Soc. Scient. Upsal.*, *3*:124.
Amaurobius: Simon, 1892. *Hist. Nat. des Araignees, 1*:237.
Walmus: Chamberlin, 1947. *Ann. Ent. Soc. Am.*, *40*:10.
Amaurobius: Locket & Millidge, 1953. *British Spiders, 2*:17.
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Characters: Cephalic region broad and rounded infront. Eyes not very different in size, all pale in colour; anterior row straight or very slightly procurved, posterior row straight or recurved. Sternum not prolonged between the posterior coxae. Labium notched at the base, longer than broad, reaching beyond the mid-point of maxillae. Chelicerae strongly convex at the base, geniculate and robust; fang groove with three or four retromarginal and two or three promarginal teeth, promargin also with scopula. Cribellum divided into two parts. Femora with well developed dorsal spines. Epigyne various, from large median and small lateral lobs to small median and large lateral lobs. Male with three tibial processes. Embulus short, curved and ends at the most distal part of alveolus.

Amaurobius nathabhaii sp. nov. (Fig. 1, a-c)

General: Body brown to light-brown. Total length 6.00 mm. Carapace 2.72 mm long, 2.36 mm wide; abdomen 3.80 mm long, 3.00 mm wide.

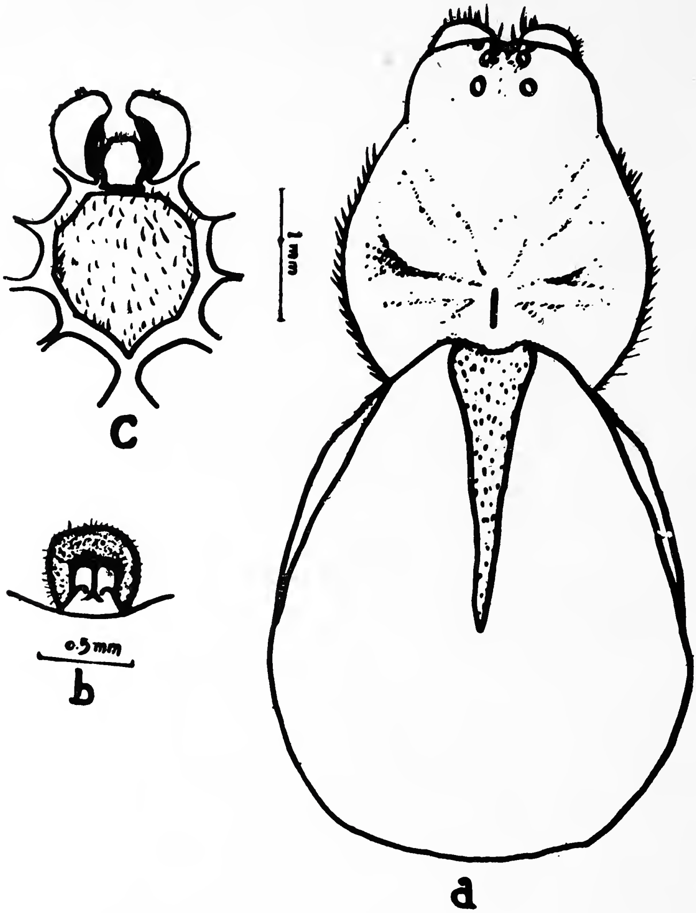

Fig. 1. *Amaurobius nathabhaii* sp. nov.
a. Dorsal view of female, legs omitted; b. Epigyne; c. Sternum, labium and maxillae.

Cephalothorax: Brown, slightly longer than wide, cephalic region broad and high anteriorly, separated by a groove, thorax with a fovea. Ocular quad longer than wide, narrower in front. Eyes pale in colour; eyes of posterior row larger than the eyes of anterior row; anterior row very slightly procurved as seen from the front, posterior row strongly recurved; anterior median eyes slightly larger than the anterior laterals and little nearer to the laterals than to each other, posterior laterals slightly larger than the posterior medians. Clypeus very narrow. Chelicerae reddish-brown, convex at the base and with scopulae at the anterior end, fang groove provided with three retromarginal and two promarginal teeth. Sternum heart-shaped, clothed with hairs, pointed behind, not projecting between the posterior coxae. Labium longer

than broad, notched at the base and reaching beyond the mid-point of maxillae. Sternum, labium and maxillae as in Fig. 1, c. Legs long, brown, with dark brown bands and covered with hairs and thick spines.

Abdomen: Light-brown with yellow patches in the background on the dorsal side, oblong, broader posteriorly, overlapping the posterior region of cephalothorax in front. Ventral side lighter in colour. A mid-dorsal brown wedge-shaped stripe, starts from the anterior end of abdomen and extends upto one half length posteriorly as in Fig. 1, a. Dorsum covered with fine hairs. Epigyne as in Fig. 1, b.

Holotype: One female in spirit.

Type-locality: Vallabh Vidyanagar, *c* 6 kilometres west of Anand, Dist. Kaira, 10-ix-1967. Coll. B. H. Patel.

Distribution: Known from the type-locality only.

This species resembles to *Amaurobius koreanus* Paik, but differs as follows: (i) Anterior row of eyes very slightly procurved, posterior row strongly recurved and anterior laterals smallest but in *A. koreanus* anterior row of eyes procurved, posterior row nearly straight and anterior laterals largest. (ii) Chelicerae reddish-brown, with three retromarginal and two promarginal teeth but in *A. koreanus* chelicerae reddish-black, with four retromarginal and five promarginal teeth. (iii) Legs handed with dark-brown bands but in *A. koreanus* no such bands on legs. (iv) Abdomen oblong, broader posteriorly, light-brown with irregular yellowish patches in the background and a mid-dorsal wedge-shaped stripe on dorsal side but in *A. koreanus* abdomen oval, brownish-black in background, a pair of pale longitudinal stripes on dorsal side and dorsum with yellowish-brown chevrons. (v) Structure of epigyne also differs.

ACKNOWLEDGEMENTS

Our sincere thanks are due to Dr. B. K. Tikader, Deputy Director, Zoological Survey of India, Western Regional Station, Poona 5, for the confirmation of the specimen and valuable suggestions. We are also thankful to the Chairman, Dr. H. M. Patel (I.C.S. Retd.) and Secretary Shri C. D. Desai of Charutar Vidyamandal and Ex-Principal Shri J. G. Chohan, Vithalbhai Patel Mahavidyalaya, Vallabh Vidyanagar for the inspiration and facilities provided to carry out the work.

Two new species of the genus *Hartertia* Seurat, 1915 (Nematoda: Spiruridae) from Rajasthan, India[1]

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(*With five text-figures*)

During August and October, 1970 two specimens of the Great Indian Bustard were examined for helminths and two species of the genus *Hartertia* Seurat, 1915 collected from the birds are described below.

Hartertia nigriceps sp. nov.
(Figs. 1-3)

Material: 6♂♂ and 9♀♀.

Diagnosis: Long, cylindrical body. Cuticle transversely striated. Mouth with two large distinctly trilobed lips, inner surface of which provided with a number of teeth. A short vestibule present. Oesophagus divided into smaller muscular anterior part and larger glandular posterior part. Cervical alae covering almost the whole length of the oesophagus. Caudal alae in males usually irregularly folded, provided with 4 pairs of preanal and 1 pair of postanal pedunculated papillae. In addition the tail tip provided with three pairs of sessile papillae. Spicules unequal. In females the tail is conical and vulva is situated in anterior third of the body.

MALE: 33-41[2] in length and .792-.954 in diameter. Lips .108-.117 × .126-.135, provided with one papilla subterminally. Cervical alae 3.420-4.140 × .117-.162. Oesophagus having two parts, the anterior, shorter and muscular part measuring .432-.450 and the posterior, larger and glandular part measuring 4.320-4.356. Nerve ring .468-.504 from the anterior end. Spicules greatly unequal, smaller .756-.810 × .027-.036 and larger 1.566-3.780 × .024-.030. Tail .504-.540. Caudal alae .810-.900 ×

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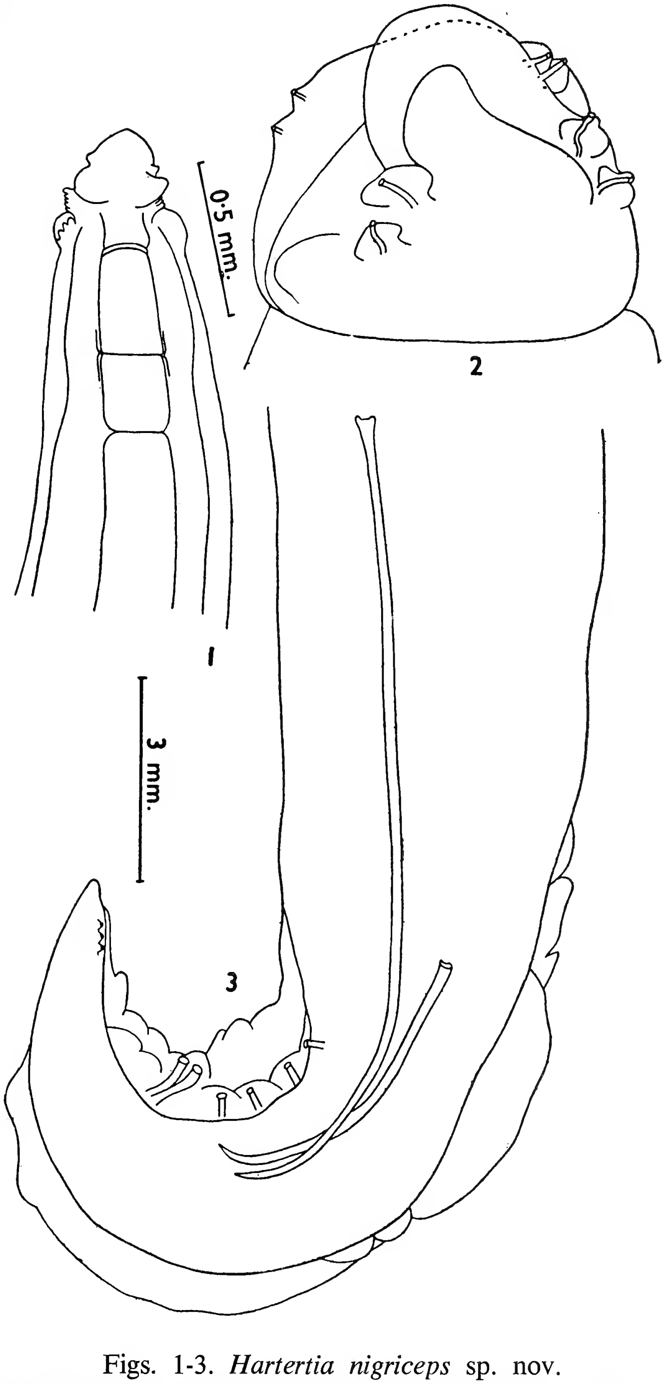
[1] Accepted March 1975.
[2] All measurements in millimetres.



Figs. 1-3. *Hartertia nigriceps* sp. nov.
Male 1. Anterior part; 2. Anterior extremity magnified; 3. Posterior part.

.144-.216, provided with four pairs of preanal and one pair of postanal pedunculated papillae measuring .108-.126 in height. In addition to tail tip provided with three pairs of sessile papillae. Caudal alae sometimes reaching the tail tip.

FEMALE: 54-60 in length and 1.080-1.206 in diameter. Lips .108-.129 long. Vestibule .072-.090. Anterior part of oesophagus .450-.504 and posterior part 4.932-4.950. Nerve ring .486-.540 from anterior end. Cervical alae 5.040-5.310 × .216. Tail straight, conical with pointed tip and measuring .288-.414. Vulva in anterior third of body length. Ova .036-.045 × .018-.021.

In the presence of cervical alae *Hartertia nigriceps* closely resembles *H. natalensis* Mönnig, 1931 and *H. rotundata* (Linstow 1883) Seurat, 1915. *H. nigriceps* can be differentiated from *H. natalensis* by smaller size of male, cervical alae, oesophagus, spicules, number of postanal caudal papillae and possession of three pairs of sessile caudal papillae, whereas *H. natalensis* has five pairs of sessile papillae. *H. nigriceps* differs from *H. rotundata* in possesing comparatively larger cervical alae, vulva in the anterior third of body, smaller eggs and three pairs of sessile caudal papillae. In *H. rotunda* cervical alae are about 1/5th of the body length, vulva posterior to anterior third of body and five pairs of sessile caudal papillae.

Host: Great Indian Bustard, *Choriotis nigriceps.*

Location: Intestine.

Type-locality: Pokaran (Jaisalmer district), Rajasthan.

Hartertia rajasthanensis sp. nov.
(Figs. 4 & 5)

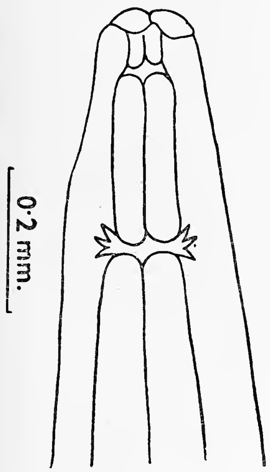
Material: 24 ♂♂ and 42 ♀♀.

Diagnosis: Long, cylindrical body. Cuticle transversely striated. Mouth with two lateral trilobed lips, each lobe further subdivided into two parts. Two lateral cephalic papillae situated near the base of the lip. A linear row of fine cervical papillae. Vestibule very short, 0.043-0.072. Oesophagus consisting of two parts, an anterior shorter and muscular part and the posterior longer and glandular part. Nerve ring situated close to the junction of glandular and muscular parts of the oesophagus, .343 from the anterior extremity. No cephalic alae.

MALE: 23-26 in length and .540-.720 in diameter. Ratio of tail to body length 1:72. Lips measuring .031 × .055. Anterior muscular part of oesophagus .261-.410 long. Posterior glandular part 4.090-4.450. Tail strongly coiled ventrally. Cervical papillae reaching posteriorly .099-.126 from anterior extremity of the worm. Caudal alae supported by 4-

pairs of preanal and 2 pairs of postanal pedunculated papillae. The first pair of preanal papillae .144-.180 from anus. The last postanal papillae .144-.162 behind anus. A pair of greatly unequal spicules, the larger 2.790 × .027 and the smaller .614-.666 × .033. Extruded spicules .295-.306. Cloacal aperture .306-.360 from posterior extremity. Tail bluntly rounded and provided with a pair of caudal alae 1.206 × .196.

FEMALE: 30.5-31.5 in length and .720-.738 in diameter. Ratio of tail to total length of body 1:150. Vulva near middle of body length. Didelphous opposed uterus, its anterior arm reaching a little in front of posterior end of oesophagus. Thick shelled embryonated ova .041-.051 × .029-.031.



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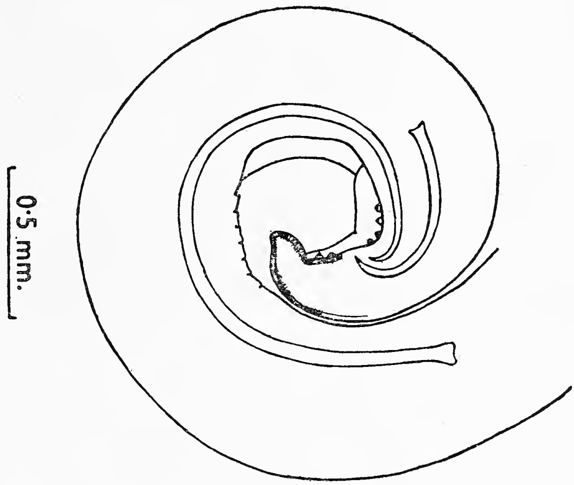

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Figs. 4-5. *Hartertia rajasthanensis* sp. nov.
Male. 4. Anterior end; 5. Posterior end.

In the great dissimilarity in the size of spicules *Hartertia rajasthanensis* closely resembles *H. obesa* Seurat, 1915, from which it can be distinguished by the possession of vulva at the middle of body length as against anterior third in *H. obesa,* smaller size of ova, smaller size of females and smaller tail 1:72 in male and 1:150 in female as against 1:31 and 1:27 respectively in *H. obesa.* In all the species ratio of tail to body length is larger in females but in *H. rajasthanensis* tail in females is shorter compared to body length.

This is the first report of the occurrence of the genus *Hartertia* from India.

Host: Great Indian Bustard, *Choriotis nigriceps* (Vigors).
Location: Intestine.
Type-locality: Pokaran (Jaisalmer District), Rajasthan.

Type specimens to be duly deposited in the National Zoological Collections in the Zoological Survey of India, Calcutta.

Acknowledgements

We are thankful to the Director, Zoological Survey of India, Calcutta for the facilities during the work, to Shri H. C. Gupta, Divisional Forest Officer, Jodhpur and Shri Y. D. Singh, Zoo Supervisor, Jodhpur for providing the opportunity of collecting the parasites. Thanks are due to Dr. B. K. Tikader, Poona for his kind interest in the work.

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A new medusa (Coelenterata: Hydrozoa) the genus *Aglauropsis* from Bombay Seas[1]

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(*With two plates*)

The genus *Aglauropsis* of F. Müller (1865), was based on a medusa found off the coast of Brazil. But the description of the type-species, *A. agassizii,* is so vague and imperfect that it just defines the generic characters. Browne (1902) described *Aglauropsis conanti* from the Falkland Islands. Kramp (1955) described a new species, *Aglauropsis jarli,* for a medusa from the west coast of Africa.

While collecting plankton from Bombay harbour, we came across nine specimens of an *Aglauropsis,* which, on closer examination, turned out to belong to a new species.

Aglauropsis vannuccii sp. nov.

Umbrella bowl shaped, with an inverted margin; a little wider than high. Diameter of umbrella, in the holotype, 8 mm; height 6 mm. Margin of the umbrella, although thick, looks quite thin when compared to the moderately thick jelly. Apical projection absent. Stomach small and hangs within the umbrella and has small, marginally thickened, folded lips; the hanging part measures 1.7 mm. Velum broad. Peduncle absent. Four radial canals united around the margin by a narrow ring canal. Radial canals simple, unbranched, and of intermediate width. In some specimens one quadrant (*i.e.,* the distance between one radial canal and the next) is wider than the adjacent quadrant, but two opposite quadrants are always of the same width.

Gonads four in number and are borne on the radial canals. Gonads commence a little away from the stomach, and run along three-quarters the length of the radial canals. Gonads smooth, sac-like, with the distal

[1] Accepted November 1974.

end thick and pendant. Each gonad is of the same thickness as the width of the radial canals, and measures about 3.5 mm. About 0.8 mm of the gonad is completely free at its lower end, this lower part being broader than the upper part. At the middle of the lower part a diffuse black patch is present. There are, in the holotype and in the other adult specimens, 28 hollow marginal tentacles. Tentacles similar and with several rings of nematocyst clusters. They are very long with globular bulbs devoid of ocelli. Bulbs occur inside the margin, and the tentacles commence above these bulbs, so that the tentacles appear to protrude a little above the margin of the umbrella. Tentacles devoid of adhesive pads and are not arranged in groups. No rudimentary tentacles at the margin. Statocysts numerous and vary from 24 to 28, there being almost always one statocyst between each pair of tentacles. Statocysts internal and are provided with an endodermal axis. Marginal as well as lateral cirri are absent.

The medusa is colourless but the gonads and the marginal bulbs are yellow in colour. However, the vividness of the coloration differs in the various specimens depending on the maturity of the animal. The number of the tentacles also increases with the size of the medusa.

Main measurements of nine specimens of the new species are given in the accompanying Table.

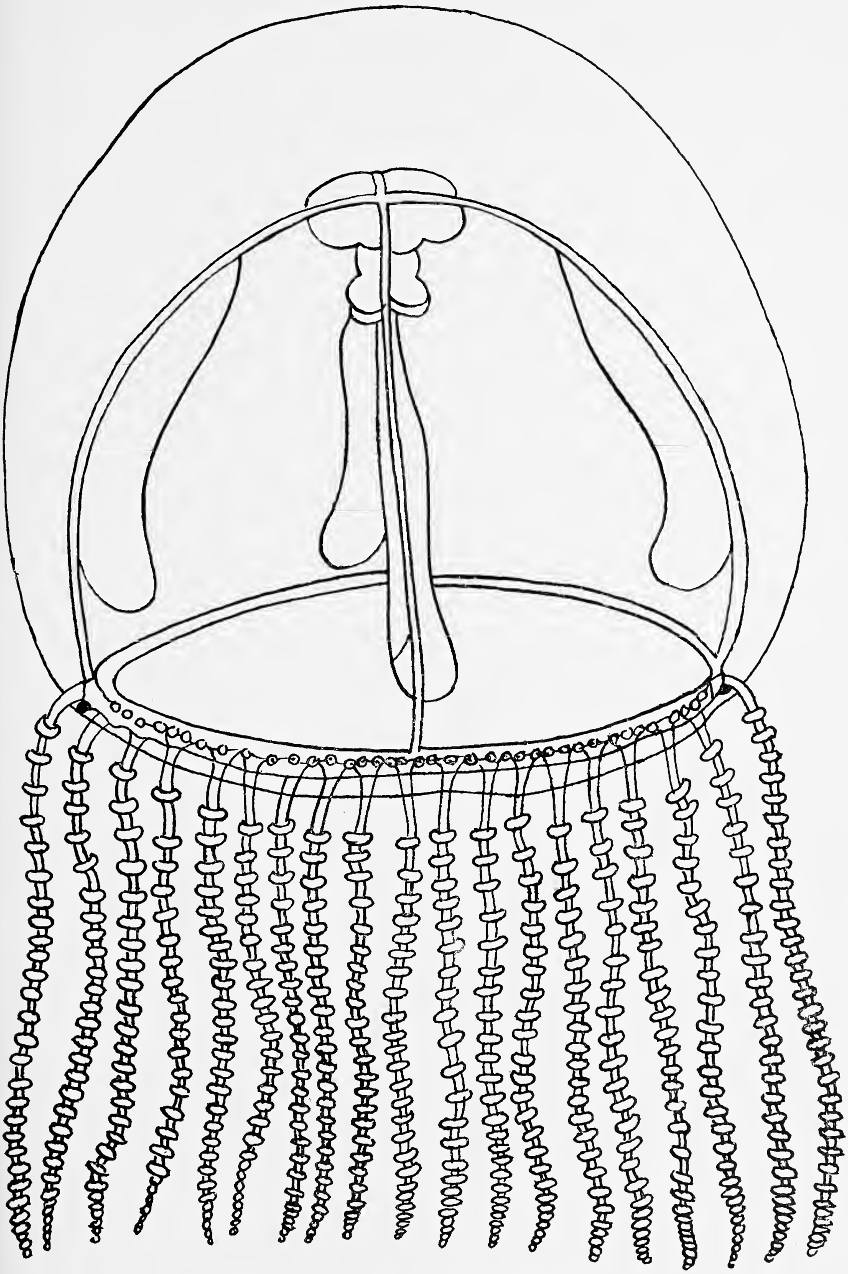
TABLE 1

Bell diameter	Umbrella height	Stomach length	Gonad length	Length of Gonad free of umbrella	Tentacle & statocyst number
8.0*	6.0	1.7	3.5	0.8	28
5.7	4.0	1.0	2.0	0.4	28
5.5	4.0	1.0	2.0	0.4	28
5.0	3.6	0.8	1.9	0.3	28
4.0	3.5	1.0	1.5	0.3	28
3.0	2.6	0.8	1.7	0.3	24
3.0	2.6	0.8	1.7	0.3	24
3.0	2.9	0.8	1.6	0.3	24
2.9	2.3	0.6	1.2	0.2	24

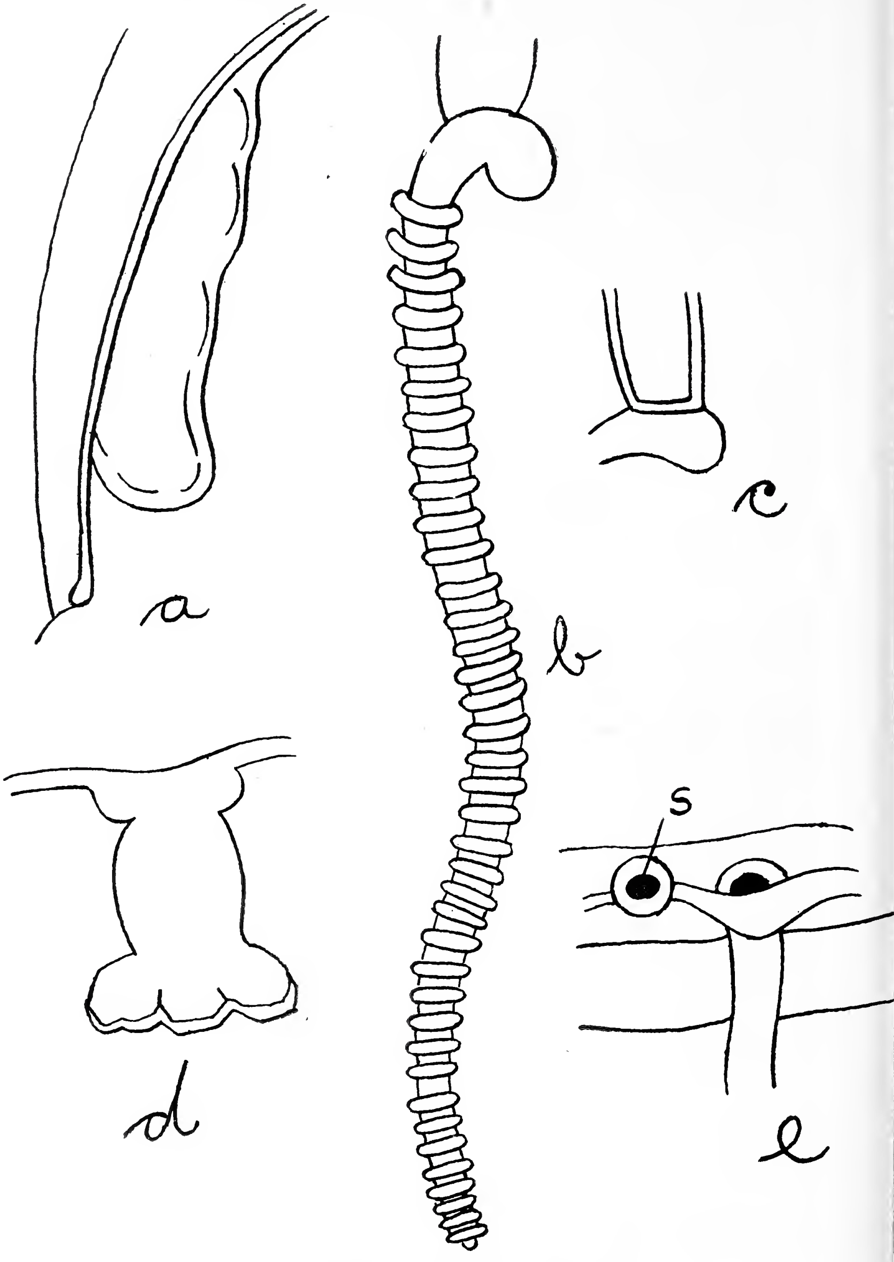
Dimensions of various body parts in five adult and four immature specimens of *Aglauropsis vannuccii*. All measurements are in millimetres.
* Holotype.

Discussion:

The genus *Aglauropsis* now includes four species, but one of these, *A. agassizii* Müller, has been very vaguely and imperfectly described. The present species has all the characters of the genus, but does not agree fully with any of the earlier described species.



Aglauropsis vannuccii, medusa.
All the tentacles are not figured.



Aglauropsis vannuccii sp. nov.

a—gonad; *b*—tentacle with mematocyst rings; *c*—margin of umbrella; *d*—mouth with lips; *e*—margin of umbrella showing statocyst(s).

The new species agrees with *Aglauropsis jarli* Kramp in having its tentacles provided with nematocyst rings, a small stomach, and in having smooth gonads with pendant distal ends. However, it differs from *A. jarli* in the presence of four lips on the mouth, in the absence of rudimentary tentacles, in the number of statocysts, and in the gonads extending along nearly three-quarters of the radial canal from the stomach to the ring canal.

The new species resembles *Aglauropsis conanti* Browne in the absence of rudimentary tentacles and in having the mouth with four folded lips, but differs from it in the absence of spirally and closely arranged nematocysts on the tentacles, presence of a short stomach, in the gonads being restricted to the first three-quarters of the radial canals and being without transverse lobes, in the number of statocysts, and in the breadth of the radial canals.

The salient differences between the three species are given below:

Aglauropsis conanti Browne (1902)	*Aglauropsis jarli* Kramp (1955)	*Aglauropsis vannuccii*
200 tentacles packed in two or three rows, with transverse band of nematocysts either surrounding the tentacles or slightly spirally arranged.	24 tentacles with nematocyst rings.	28 tentacles with nematocyst rings (in adults).
No rudimentary tentacles.	Some of the tentacles rudimentary.	No rudimentary tentacles.
Stomach fairly long.	Stomach very small.	Stomach small.
Mouth with four large folded lips.	No distinct lips on mouth.	Mouth with four small folded lips.
Radial canals broad.	Radial canals narrow.	Radial canals of intermediate width.
Gonads extending along nearly whole length of radial canals.	Gonads only on distal half of radial canals.	Gonads extending along nearly proximal three-quarters of radial canals.
Gonads transversely lobed.	Smooth distal end of the gonads pendant.	Gonads smooth, sac-like, distal end pendant.
50 or more statocysts.	24 statocysts.	In adults, 28 statocysts —almost one between every two tentacles.

The new species is named *Aglauropsis vannuccii,* in honour of Dr. (Mrs.) Martha Vannucci, former Curator, Indian Ocean Biological Centre, Cochin (India).

The holotype, collected in Bombay harbour on 26-v-1971, and paratype, collected from the same location on 29-v-1971, have been deposited in the Zoological Survey of India, Calcutta (reference nos. P. 2716/1, and P. 2717/1 respectively).

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A new species of Poaceae (=Gramineae), from Karnataka[1]

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(*With a plate*)

During my plant collection trips, to various parts of India, for our Phytochemical studies, I have collected a number of taxonomically interesting plants. One of them, a new grass, is described here and is dedicated to my mother, Megdelin.

Capillipedium magdaleni sp. nov.

Species est similis *Capillipedio filiculmi* (Hook. f.) Stapf, sed differt ab eo habitu perenni et glabris nodis. Differet ab omnibus aliis speciebus *Capillipedii* longioribus aristis.

Holotypus, M. R. Almeida—2566, lectus ad Agumbe in Karnataka septentrionali mense Novembri anni 1972 et positus in BLAT, Bombay; Isotypus sub eodem numero positus in Horto Kewensi (K) in Anglia. Paratypus, M. R. Almeida—2941, lectus ad Agumbe in Karnataka die 3 Novembris anni 1973 et positus in BLAT.

Capillipedium magdaleni sp. nov.

An erect or sub-erect perennial grass, occurring on sides of a waterfall, sufrutescent, below, interlaced, copiously geniculately branched, ± 20 cm tall, sometimes proliferous. Internodes up to 3 cm long. More than half of the internode is always covered by a leaf-sheath. Nodes glabrous. Leaf-sheath ± 3 cm long, mostly adpressed to the internodes except in case of some basal sheaths which are divaricate, ending in a ciliate, bilobed, membranaceous ligule. Leaves up to 4 cm long and ± 3 cm broad, linearlanceolate, slightly acuminate. Inflorescence in a terminal panicle, with 1-4 joints, 1-2 cm long (excluding the length of the awns). Rachis capillary, glabrous. Spikelets in pairs; one sessile and other pedicellate, dull-brown in colour. Sessile spikelets ± .2 cm long, linear-lanceolate, with a prominent callus near the base, containing a pistillate flower; outer glume ± 2 mm long linear-lanceolate,

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[1] Accepted March 1975.
[2] Contribution No. 400 from CIBA-GEIGY Research Centre.

acute, 5-nerved, slightly villous on the back, keeled along the margins; inner glume ± 1.5 mm long, linear-lanceolate, acute at the apex, 3-nerved, glabrous; outer lemma sometimes ± 1 mm long, linear-acuminate, hyaline, unnerved or sometimes represented by awn, ± 2 cm long, with a dilated base; inner lemma is represented by an awn which is ± 6 cm long, without a dilated base; palea absent; lodicules 2, small, spathulate, hyaline. Ovary ± 2 mm long, with 2 plumose stigmas which are ± 1 mm long. Pedicelled spikelets ± 3 mm long, lanceolate, without a callus, containing staminate flowers. Pedicels ± 1 mm long with a median transluscent groove; outer glume ± 3 mm long, lanceolate, acute at the apex, keeled along the margins, 7-9 nerved, glabrous; inner glume ± 2.5 mm long, lanceolate, slightly acuminate, keeled and ciliate along the margins, hairy on the back on upper half; upper lemma ± 2 mm long, ovate-lanceolate, hyaline; lower lemma and paleas are absent, stamens 3; anthers ± 1.5 mm long.

Holotype: M. R. Almeida—2566, is collected from Agumbe, in Karnataka, in November, 1972 and is deposited in BLAT, Bombay. Isotype is the duplicate of the same collection and is deposited in Kew Herbarium (K).

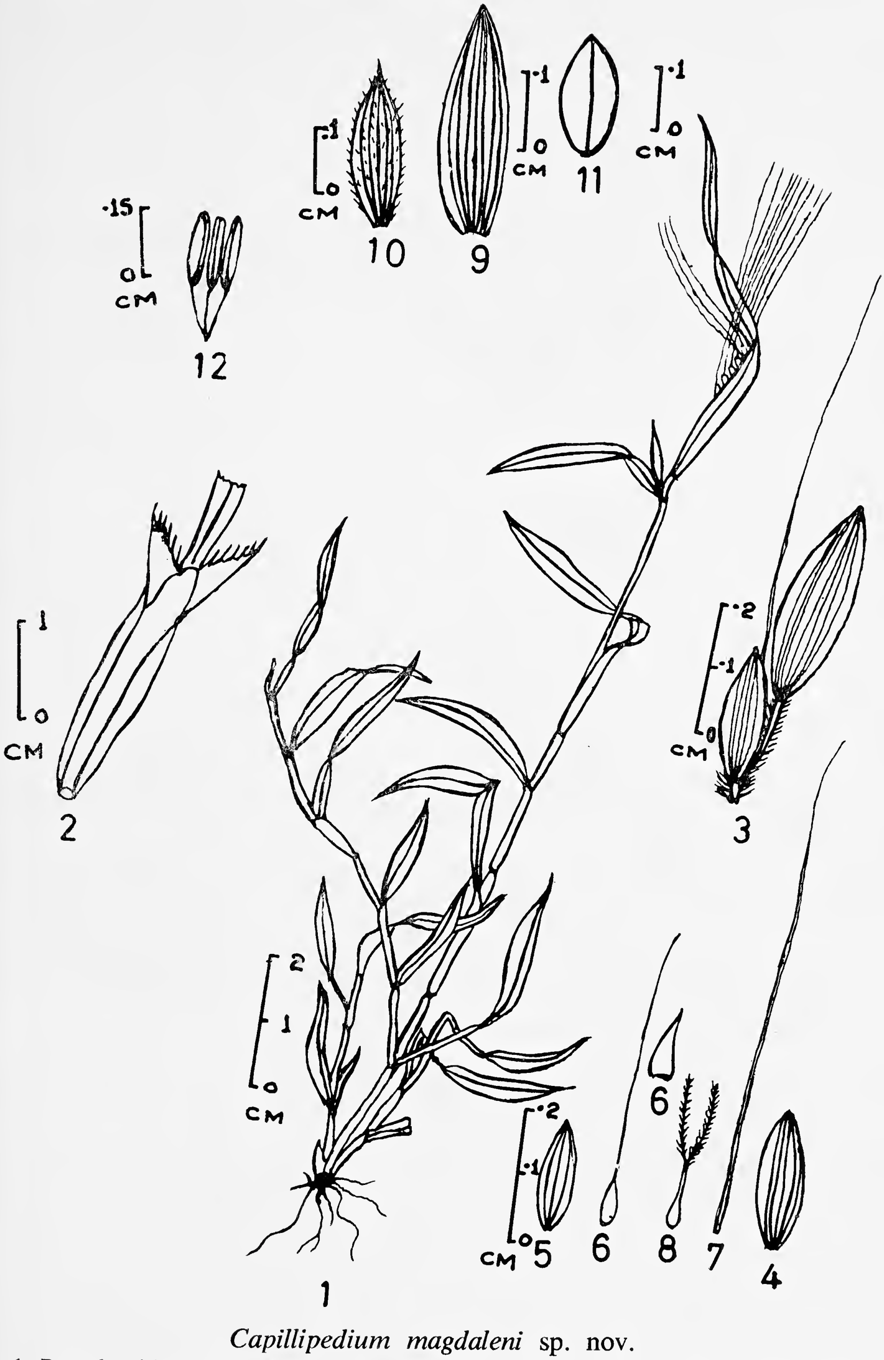
Paratypes: M. R. Almeida—2941 collected from same place on November 3, 1973 are deposited at BLAT.

This grass is seen at only one spot growing on the sides of a waterfall on rocky substratum. It differs from other species of *Capillipedium* in having compartively longer awns and is very closely allied to *Capillipedium filiculme* (Hook. f.) Stapf, from which it could be distinguished by the following characters:

C. filiculme (Hook. f.) Stapf	*C. magdaleni*
1. Annual grass	1. Perennial grass
2. Plants 61-91 cm tall	2. Plants less than 61 cm tall
3. Nodes bearded	3. Nodes glabrous
4. Leaves 6-10 cm long	4. Leaves ± 4 cm long
5. Spikelets pale-green or white	5. Spikelets dull-brown
6. Awn 1-2 cm long	6. Awn 5-7 cm long

ACKNOWLEDGEMENTS

I wish to express my gratitude, for the facilities and for some useful discussions, to Prof. P. V. Bole and for Latin Diagnosis, to Rev. Fr. Conrad Mascarenhas.



Capillipedium magdaleni sp. nov.

1. Branch with inflorescences; 2. Leaf-sheath showing ligule; 3. Pair of spikelets; 4. Outer glume of sessile spikelets; 5. Inner glume of sessile spikelet; 6. Outer lemma of sessile spikelet; 7. Inner lemma of sessile spikelet; 8. Gynaecium of sessile spikelet; 9. Outer glume of pedicelled spikelet; 10. Inner glume of pedicelled spikelet; 11. Outer lemma of pedicelled spikelet; 12. Androecium of pedicelled spikelet.

Eulaliopsis duthiei (Poaceae)- a new species from India[1]

P. R. SUR[2]
Central National Herbarium, Botanical Survey of India, Botanic Garden, Howrah 3

(*With a text-figure*)

The genus *Eulaliopsis* Honda (Poaceae) was till recently known to be represented in India by one species *E. binata* (Retz.) C. E. Hubbard and another species *E. sykesii* Bor in kew Bull. 1957, 412 (1958), was known from Nepal. One more species has been found, collected by J. F. Duthie (No. 14 date 11-vi-1883) from Ganga Valley (Tehri-Garhwal) and is named and described here.

Eulaliopsis duthiei sp. nov.

A *E. binata* (Retz.) Hubbard praecipue differt culmis simplicibus, foliis Parvioribus, 7-14 cm longis, spiculis sessilibus majoribusque, superioris lemmatis arista longiore, 6-8 mm, flosculo inferiore sterili.

Herba perennis. Culmi simplices, caespitosi, basi lanati, 30-33 cm longi, 1 mm diam., erecti, non-ramosi, glabri, 4-5 nodi. *Folia* 4-15 cm longa, 1-1.5 mm lata, angustata in acumina subpungentia, concava, basi obtusa, fimbriata, vaginis glabris, *ligula* pilorum brevium. *Racemi* 2, terminales, graciles; *spicula sessilis* 4-4.5 mm longa, callus pilosus; *inferior gluma involucralis* 3.5 mm × 1 mm, elliptica-oblonga, chartacea, 2-3-dentata, 5 nerva, infra ciliata pilis longis; *superior gluma involucralis* 4.5 mm × 1.3 mm, membranacea, ovatolanceolata, 2-dentata, 3-5 nerve, *arista* brevissima subterminali 0.7 mm longa. *Inferior gluma floralis* cassa, 3 mm × 1.5 mm, oblongo-obtusa, irregulariter 2-dentata, hyalina, nervo solitario ad medium, *Palea* nulla; *superior gluma floralis* hermaphrodita, 3.5 mm × 1 mm, linearis, hyalina, 2-dentata, *aristata,* arista 6-8 mm longa, *Palea* 1.5 mm longa, apice dense ciliata; *stamina* 2 *anthera* 2. 5 mm longa, *filamentum* brevissimum; *ovarium* oblongum, *styli* longi, *stigmata*-2.

Eulaliopsis duthiei sp. nov.

This species differs from *Eulaliopsis binata* (Retz.) Hubbard in the

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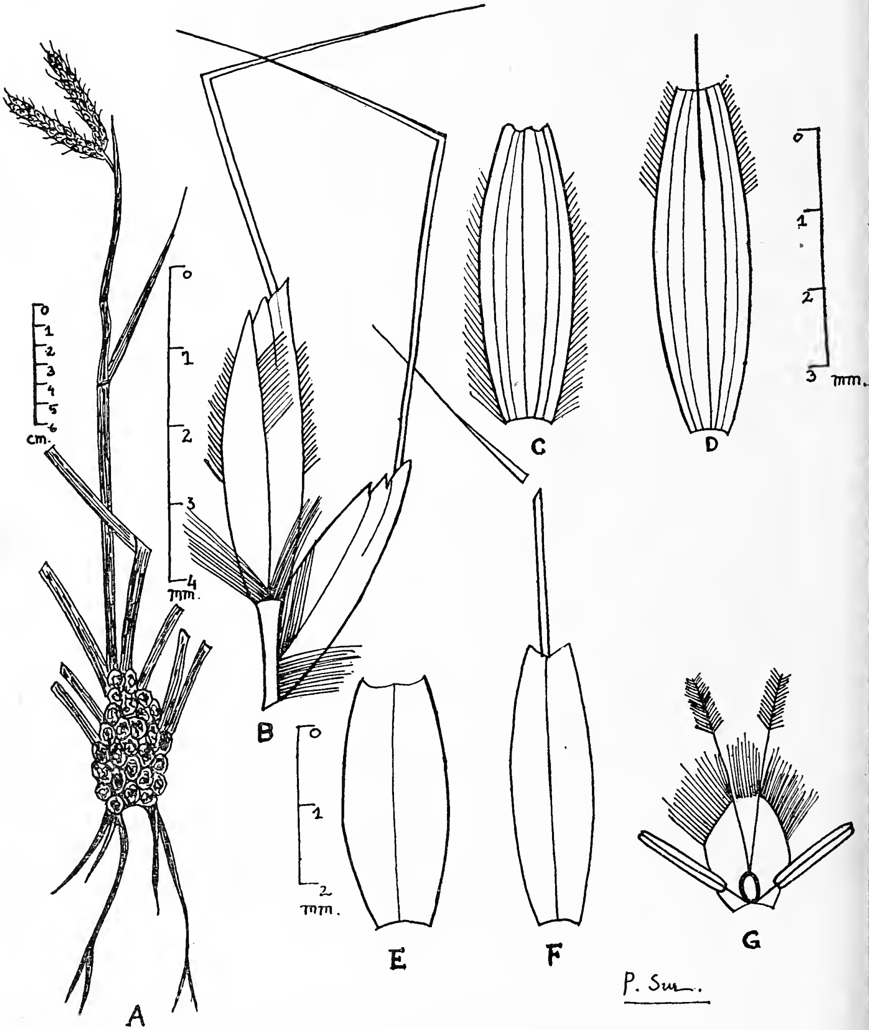
[1] Accepted September 1974.

[2] *Present address*: Botanical Survey of India, Industrial Section, Indian Museum, 1, Sudder Street, Calcutta 700 013.

simple culms, shorter leaves; shorter sessile spikelet; shorter awn of upper glume; shorter awn of upper lemma and sterile lower floret.

Herb—Perennial. *Culms*: simple; tufted; woolly at the base, 30-33 cm × 1 mm erect, unbranched, glabrous; 4-5 noded. Leaves: 4-15 cm × 1-1.5 mm; tapering into a sub-pungent acumen; concave; base obtuse; fimbriate; sheath glabrous, ligule of short hairs. *Racemes*: 2; terminal; slender, *Sessile spikelet;* 4-4.5 mm long, callus hairy. *Lower involucral glume*: 3.5 mm × 1 mm; elliptic oblong; chartaceous; 2-3 toothed; 5-nerved; lower part of the glume ciliate with long hairs. *Upper involu-*



Eulaliopsis duthiei sp. nov.

A. Habit; B. spikelets; C. lower involucral glume; D. upper involucral glume; E. lower floral glume; F. upper floral glume; G. Andro-gynoecium with palea.

cral glume: 4.5 mm × 1.3 mm; membranous ovate lanceolate 2-dentate; 3-5 nerved; *awn* very short, subterminal, 0.7 mm long, *lower floral glume*: empty; 3 mm × 1.5 mm; oblong; obtuse; irregularly—2-dentate; hyaline; one nerve at the middle. *Palea*—0. *Upper floral glume*: Hermaphrodite: 3.5 mm × 1 mm; linear; hyaline; 2-dentate; awned. *Awn*: 6-8 mm long. *Palea*: 1.5 mm long; densely ciliate at the top. *Stamens*: 2. *Anther* 2.5 mm long; filament very short. *Ovary*: oblong. *Style*: long. *Stigmas* 2.

Holotype: India, Uttar Pradesh, Ganga Valley (Tehri-Garhwal) 11-vi-1883, J. F. Duthie-14 (deposited in the Central National Herbarium, Calcutta).

KEY TO THE SPECIES OF *Eulaliopsis*

1. Culms branched, leaves 30-60 cm × 6.5-7.5 mm; sessile spikelet 3.5 mm long; awn of upper glume 1-1.5 mm long; awn of the upper lemma 3-4.5 mm long. .... *binata*
1. Culms simple; leaves up to 20 cm × 2 mm; spikelet longer; awn of upper lemma longer.
   2. Leaves 15-20 cm × 2 mm; sessile spikelets 5 mm long, awn of upper glume 8-8.5 mm long; awn of upper lemma 18-20 mm long. .... *sykesii*
   2. Leaves 7-14 cm × 1.5 mm; sessile spikelets 4-4.5 mm long; awn of upper glume 0.7 mm long; awn of upper lemma 6-8 mm long. .... *duthiei*

ACKNOWLEDGEMENTS

I am grateful to the Director, Botanical Survey of India for facilities; to Deputy Director and Keeper, Central National Herbarium, and Dr. S. K. Jain, Deputy Director, B.S.I., Eastern Circle for their kind encouragement; to Dr. R. B. Mazumder, Systematic Botanist for his valuable suggestions and to Dr. N. C. Muzumder for latin diagnosis of the species.

A synopsis of the genus *Hymenandra* A. DC. (Myrsinaceae) and a new species from Burma[1]

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Central National Herbarium, Botanic Garden P.O., Howrah 3

(*With a text-figure*)

A new species *Hymenandra narayanaswamii* from Burma is described and illustrated. The genus consists of three species: (i) *H. wallichii* A. DC. occurring in North East India and Sylhet in Bangladesh, (ii) *H. narayanaswamii* sp. nov. occurring in Tavoy, in peninsular Burma and (iii) *H. iteophylla* (Ridl.) Furtado occurring in Johore, Malaya, The genus is reviewed and a key to the species so far known is presented.

A De Candolle (Trans. Linn. Soc. 27:126, 1834) proposed the genus *Hymenandra* based on *Ardisia hymenandra* Wall. typified by Wall. Cat. No. 2266 and collected from Sylhet (now in Bangladesh). The genus *Hymenandra* is characterised by pentamerous flowers, sympetalous corolla, connivent stamens to form a tube, and anthers with long produced apex. This genus differs from *Ardisia* in having stamens which connate into a tube, whereas in *Ardisia* the stamens are free. This feature of connate stamens is seen in the following genera of the family Myrsinaceae (i) *Conandrium* Mez occurring in New Guinea (ii) *Oncostemon* Juss. occurring in Madagascar (iii) *Amblyanthus* A. DC. occurring in India. But the genus *Hymenandra* differs from the above mentioned genera in several combination of characters, like pluriseriate or uniseriate ovules, filiform or thick styles, anthers with long produced apex or hardly produced apex and united or free filaments.

So far two species were known under the genus. (i) *Hymenandra wallichi* A. DC. occurring in Khasi hills, Assam, and Naga hills (India) and Sylhet (Bangladesh) and (ii) *Hymenandra iteophylla* (Ridl.) Furtado occurring in Malaya. *Hymenandra narayanaswamii* is the new species described here on the basis of specimen *P. T. Russell* 2105, collected from Tavoy, Burma. This species is named in honour of Late V. Narayanaswami of Botanical Survey of India, for his contribution

[1] Accepted September 1974.

to Indian taxonomy and who had clearly indicated in the herbarium label that it could probably be a new species of *Ardisia*.

KEY TO THE SPECIES OF *Hymenandra*

I. Nerves of leaves conspicuous:
  II. Leaf obovate-lanceolate or oblanceolate, 28-30 cm × 7-9.5 cm, base attenuate, apex rotundate, margin dentate, leaf fleshy; petiole subsessile or short, ± 5 mm long; calyx lobes ovate; apex of anther gradually attenuated .... *wallichii*
  II. Leaf oblong or oblong elliptic, 8-28 cm × 3-11 cm, base cuneate apex acute, margin entire, leaf membranous; petiole 10-12 mm long; calyx lobes triangular-lanceolate; apex of anther abruptly attenuated .... *narayanaswamii*
I. Nerves of leaves inconspicuous .... *iteophylla*

ENUMERATION

Hymenandra wallichii A. DC. in Ann. Sc. Nat. 2, ser. 16:83, t. 5, 1841; C.B. Clarke in Hook. f. Fl. Brit. Ind. 3:532, 1882; Kanj & Das, Fl. Assam 3:186, 1939.—*Ardisia hymenandra* Wall. in Roxb. Fl. Ind. ed. Carey 2:282, 1824.
Type: *Wallich* 2266 (Holotype K, isotype CAL).
Distribution: North East India and Bangladesh.
INDIA: Assam: Herb. Griffith 3596 (CAL); Meghalaya, Khasi hills, alt. 1000 m, June 1876, *sine collector* No. 312 (CAL); Nagaland, Naga hills, May 1899, *Dr. Prain's collector* 100021 (CAL).
BANGLADESH: Sylhet, *Wallich* 2266.

Hymenandra narayanaswamii sp. nov.

Affinis *H. wallichii* A.DC., sed foliis oblongis vel oblong-ellipticis, ad basin cunneatis, apice acutis, margine integeris, membranceis, petiolis 10-12 mm longis, calycis lobis triangularis-lanceolatis apicibus antherorum abrupte longe attenuatis differt.

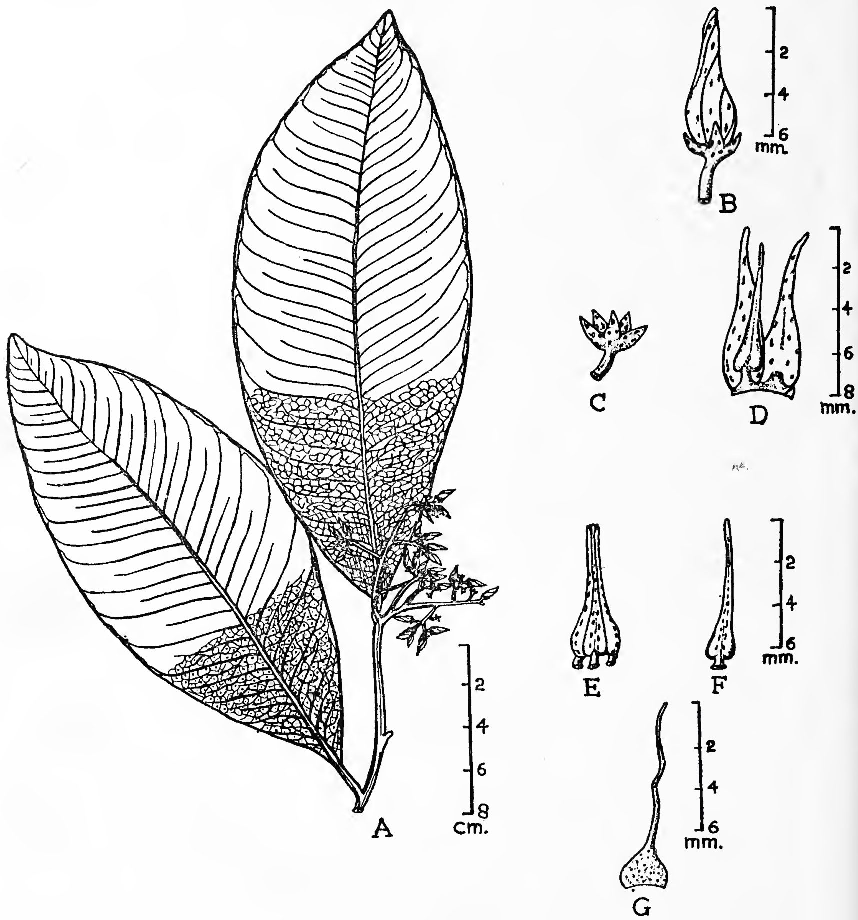
Frutex lignosus, subteretis, glaber. *Folia* magna, oblonga vel oblongo-elliptica, 8-28 cm longa, 3-11 cm lata, basi cuneata, apice acuta, margine integra, pellucido-punctata, glabra, membranacea, nervis principalibus prominentibus, nervis lateralibus 30 paribus, distinctis, tenuibus; petiolus 1-1.2 cm longus, canaliculatus. *Inflorescentiae* axillares, 4-7 cm longae, subcorymbose paniculate, foliis minoribus instructae, dense puberulae, glanduloso-punctatae; ramulis 1.5-2 cm longis flores umbellatos gerentibus. *Flores* pentameri; pedicellus 4-8 mm longus. *Calyx* 5-partitus; lobis triangulari-lanceolatis, dense puberulis, glandu-

loso-punctatisque. *Petala* 5, basi breviter connata, lanceolata, 7-8 mm longa 1.5-2 mm lata, apice longe acuminata, glandulosa-punctata, dextrorsum tegentia. *Stamina* 5, basi corollae affixa, tubulose coalita; filamentis brevissimis, 0.5 mm longis, liberis; antherae lineari lanceolatae, 6-7 mm longae, conniventae, apice longe attenuatae. *Ovarium* subglobosum, glanduloso-punctatum; stylus filiformis, 8-10 mm longus, stigmate inconspicuo.

Typus: Burma, Tavoy, *P. T. Russell* 2105 (CAL).

Hymenandra narayanaswamii sp. nov.

Shrub woody, subterete, glabrous. *Leaves* large, oblong or oblongo-elliptic, 8-28 cm × 3-11 cm, base cuneate, apex acute, margin entire, pellucid punctate, glabrous, membraneous, main nerve prominent,



A. Habit; B. Flower; C. Calyx; D. Petals with stamen; E. Stamens united into a tube; F. Stamen; G. Gynoecium.

lateral nerves in ± 30 pairs, distinct and slender; petiole 1-1.2 cm long, canaliculate. *Inflorescence* axillary, 4-7 cm long, subcorymbose paniculate, smaller than leaf, densely puberulous and glandulose dotted; branchlets end in umbellate clusters. *Flowers* 5-merous; pedicel 4-8 mm long. *Calyx* 5 lobed; lobes triangular-lanceolatis, densely puberulous and glandulose punctate. *Petals* 5, shortly united at the base, lanceolata, 7-8 mm × 1.5-2 mm, apex long acuminate, glandulose punctate, overlapping to the right. *Stamens* 5, attached to the base of the corolla, united to form a tube; filament very short, 0.5 mm long, free, anther linear lanceolate 6-7 mm long, connivent by the side of anthers, apex long attenuate. *Ovary* subglobose, glandulose-punctate; style filiform, 8-10 mm long, stigma inconspicuous.

Distribution: Burma.

BURMA: Tavoy, *P. T. Russell* 2105 (Holotype CAL).

This species is allied to *Hymenandra wallichii* A.DC. but differs in having oblong or oblong-elliptic leaves with cuneate base, acute apex, entire margin, and membranous texture, triangular lanceolate calyx lobes and abruptly attenuated apex of anther; whereas in *H. wallichii*, the leaves are obovato-lanceolate or oblanceolate with attenuated base, rotundate apex, dentate margin and fleshy texture, ovate calyx lobes and gradually attenuated apex of anther.

Hymenandra iteophylla (Ridl.) Furtado in Gard. Bull. Singapore 17:306, 1958—*Ardisia iteophylla* Ridl. in Journ. Bot. 62:298, 1924; Ridley Fl. Malay Pen. 5: Suppl. 318, 1924.

Distribution: MALAYA: Johore, Gunong Besidong, *Holttum s.n.* (Type K, not seen).

ACKNOWLEDGEMENT

We wish to thank Deputy Director, Central National Herbarium for all facilities.

New taxa of the genus *Dipcadi* Medik. (Liliaceae)[1]

D. B. Deb and Syamali Dasgupta
Industrial Section, Botanical Survey of India, Calcutta
(*With two plates*)

In the course of a taxonomic study of the genus *Dipcadi* Medik. (Liliaceae) for the revised Flora of India under the auspices of Botanical Survey of India, we discovered some novelties, two of which are described below.

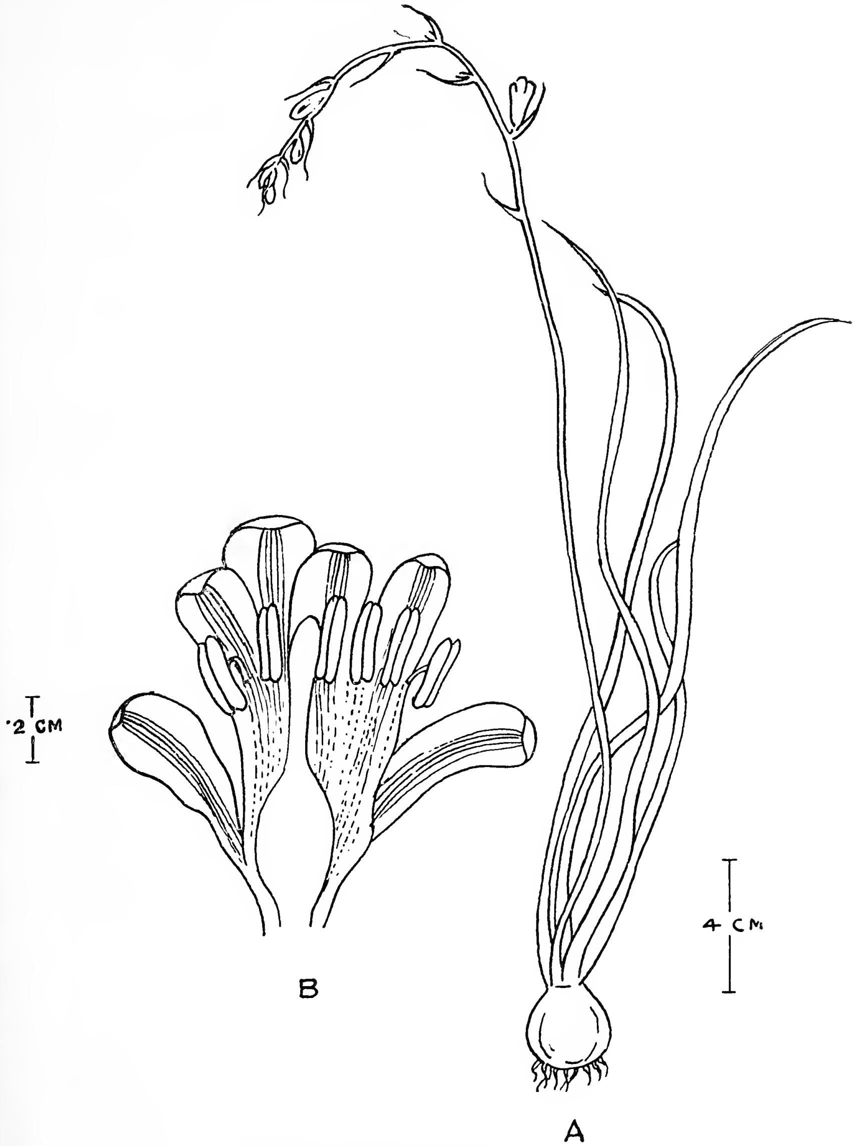
Dipcadi maharashtrensis sp. nov. (Plate 1)

Accedit ad *D. ursulae* Blatt. a qua differt foliis scapo brevioribus, racemis laxis, bracteis subulatis, acuminatis, coriaceis, pedicellis brevioribus, ovariis late oblongibus.

This species near to *Dipcadi ursulae* Blatter but differs in having leaves shorter than the scape, loose raceme, subulate, acuminate, coriaceous bracts, shorter pedicels and broadly oblong ovary.

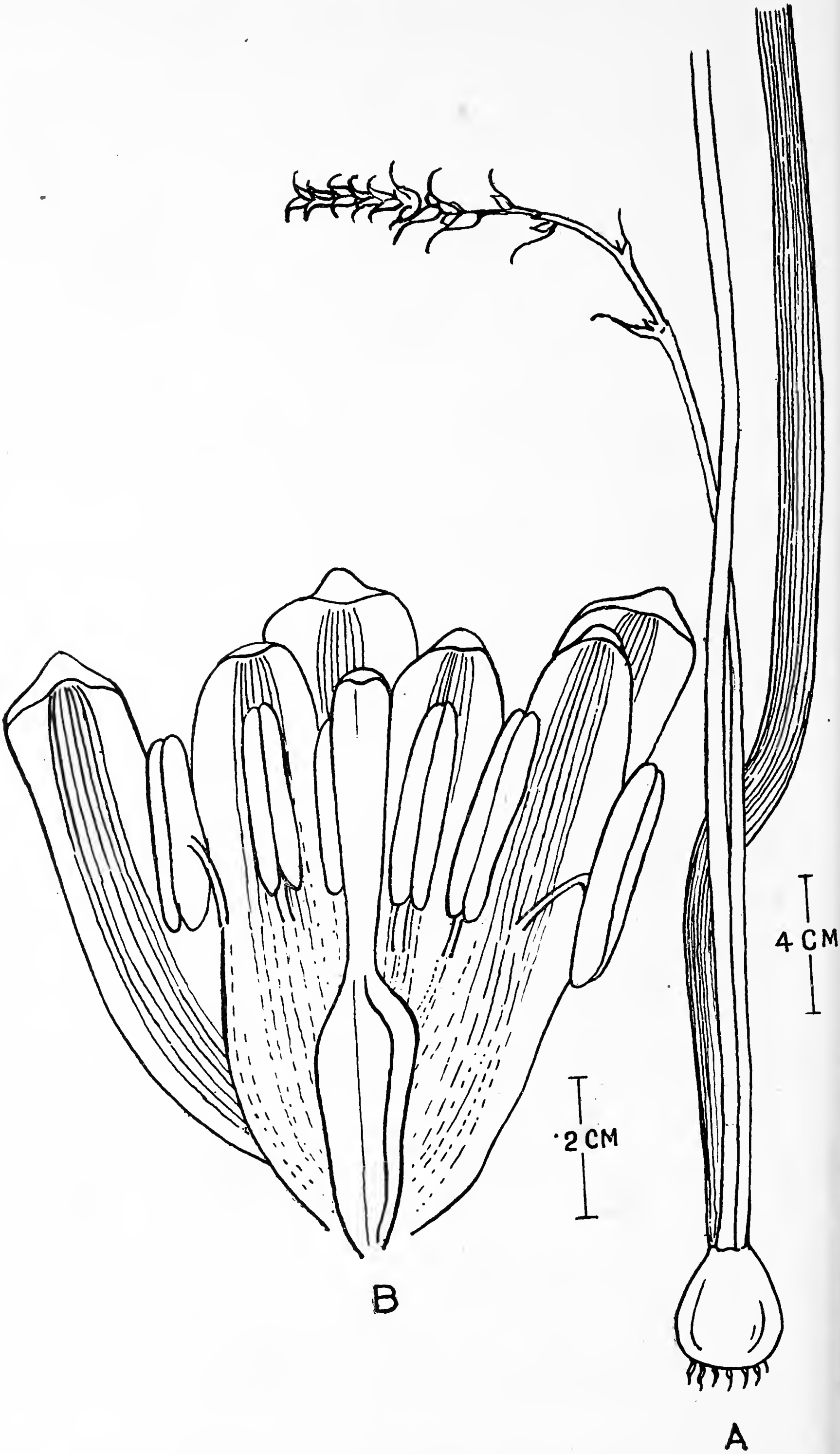
Herbs bulbous, scapigerous; bulbs globose, small, about 2.5 cm × 2.5 cm, tunicate, rooting profusely from the base. *Leaves* radical, about 6, shorter than the scape, 25-30 cm × .5-.7 cm, linear, broadest at the middle, plicate, entire, acute, coriaceous, glabrous; veins parallel, 8-14 in number. *Scape* long, about 36 cm long, about .4 cm across at the base, narrowing upwards to .1 cm across at the apex, slender, terete, glabrous, naked. *Raceme* about 13 cm long, loose, bearing about 12 flowers; bracts persistent, much longer than the pedicels, 1-2 × .3-.35 cm, entire, subulate, coriaceous. *Flowers* bisexual, regular, distantly placed; pedicels stout, 2-3 mm long. *Perianth* 1.1-1.3 cm long, petaloid, biseriate, of 3 segments each, outer ones longer, united upto 1/3 from the base, campanulate, inner ones united upto 2/3 from the base, tubular; perianth lobes 2-2.5 mm broad; obovate-lanceolate, obtuse, tuberculate at the subapex; nerves 5, convergent towards the apex. *Androecium* of 6 stamens, adnate to the perianth; filaments flat, adnate to the inner perianth tube, remaining free for about 1 mm above; anthers 2 celled, oblong, 2.5-2.7 × .6-.7 mm, dorsifixed, introrse, dehiscing longitudinally. *Gynoecium* of 3 carpels, syncarpous; ovary superior, stalked, broadly

[1] Accepted September 1974.



Dipcadi maharashtrensis sp. nov.

A. Sketch of the holotype; B. Parts of a flower.



Dipcadi ursulae Blatt. var. *longiracemosae* var. nov.
A. Sketch of the holotype; B. Parts of a flower.

oblong, 3.5-4 × 2.5-3 mm, glabrous, trilocular, with numerous ovules in axile placentas; style stout, 4-5 mm long, about .7 mm across; stigma globose, obscurely trilobed; stalks short, .5-.7 mm long, .7-1 mm across. *Fruit* not seen.

The bulb was collected from Panchgani, Maharashtra by *B. Rukmini Bai* (B.R. 433) on 5-ix-1955 and cultivated in St. Xavier's College, Bombay, where it flowered in September.

Type: The holotype *B. Rukmini Bai* 433 collected from Panchgani, Maharashtra, on 5-ix-1955, is preserved in the Blatter Herbarium (BLAT), St. Xavier's College, Bombay.

Dipcadi ursulae Blatt. var. **longiracemosae** var. nov. (Plate 2).

Accedit ad *D. ursulae* Blatt. var. *ursulae* a qua differt scapo longiore, floribus pluribus, ovariis sessilibus.

Allied to *D. ursulae* Blatt. var. *ursulae* differing in having longer scape with more flowers in the raceme and sessile ovary.

Herbs scapigerous, bulbous; bulbs ovoid, small, about 3 cm in diam. tunicate, rooting from the base. *Leaves* radical, 30-40 cm × .5-1.5 cm, linear, glabrous, entire, acute; veins parallel, 12-20. *Scape* one or two, arising from the bulb, 30-45 cm long, .4-1.2 cm across, terete, smooth naked. *Raceme* 10-15 cm long, dense in early stage, loose when matured, 22-30 flowered; bracts persistent, 1-1.3 × .3-.4 cm, deltoid, long acuminate, scarious, plicate, entire, much longer than the pedicel. *Flowers* bisexual, regular, white; pedicels 4-7 mm long. *Perianth* .9-1.1 cm long, petaloid, biseriate, of 3 segments each; outer ones longer, united up to 1/3 from the base, campanulate, lobes obovate-lanceolate, recurved at the middle, obtuse, tuberculate at the subapex; inner ones shorter, united upto 2/3 from the base, tubular, lobes obovate-lanceolate, obtuse, recurved at the tip, hooded; nerves 5-7, prominent, convergent towards the apex. *Androecium* of 6 stamens; filaments linear, adnate to the inner perianth tube, remaining free for 2-3 mm above; anthers 2 celled, linear-oblong, 3-3.5 mm × about .7 mm, dorsifixed, introrse, dehiscing longitudinally. *Gynoecium* of 3 carpels, syncarpous; ovary sessile, superior, narrowly obovate-oblong, trisulcate, 4.5 mm × about 1 mm, glabrous, trilocular, with numerous ovules in axile placentas; style 4.5-4.7 mm long, stout, broadening above; stigma trilobed. *Capsule* not seen.

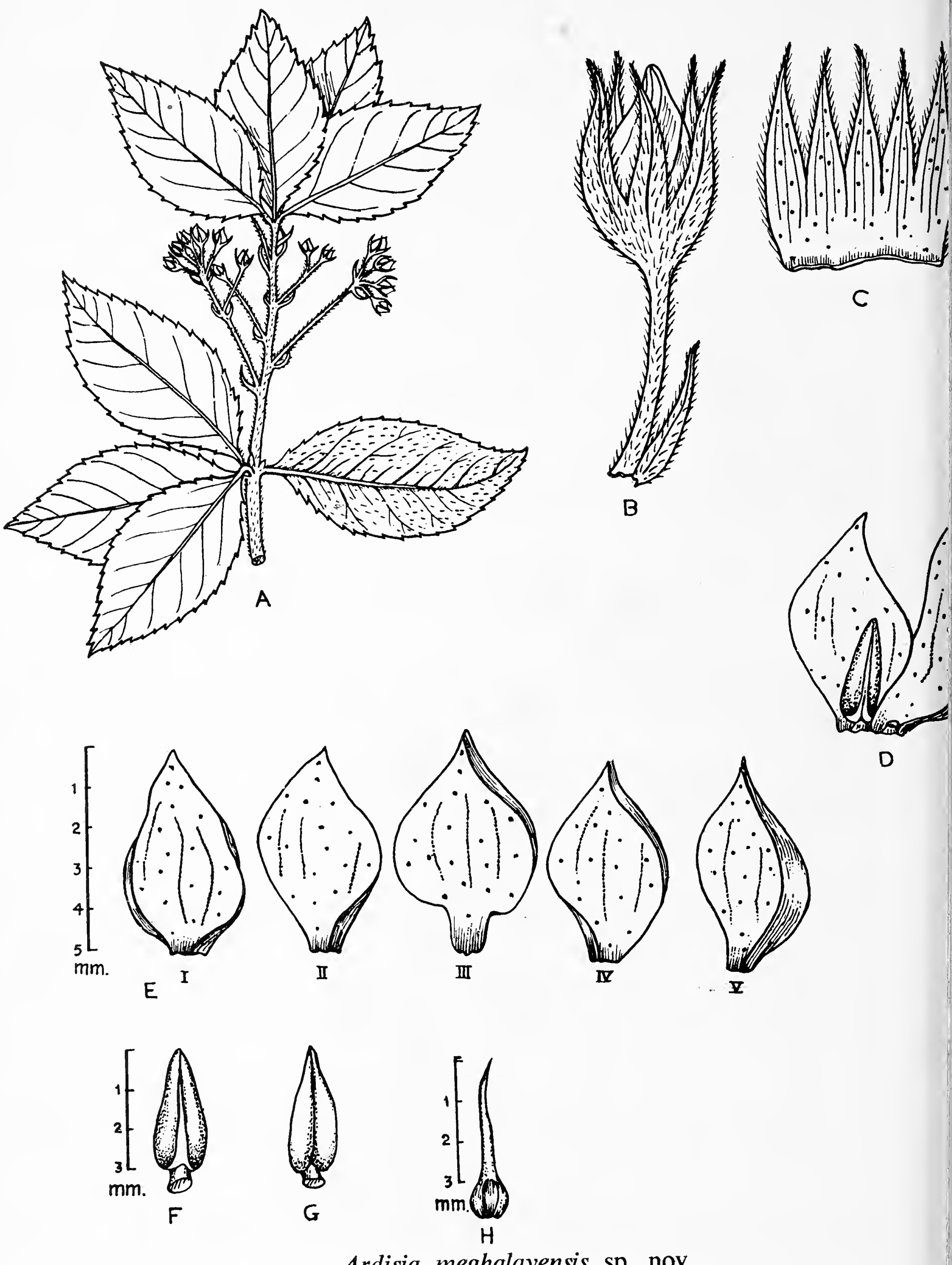
Flowering time: August.

MAHARASHTRA: Rozi, 29-viii-52, *P. V. Bole* 851; Junagadh, Girnar hill, 25-viii-1958, *P. V. Bole* 743. Common.

Type: The holotype *P. V. Bole* 743 collected from Girnar hill, Junagadh, on 25th August, 1958, is preserved in the Blatter Herbarium (BLAT), St. Xavier's College, Bombay. *P. V. Bole* 851 collected from Rozi on 29-viii-52, is designated as the paratype (BLAT).

ACKNOWLEDGEMENT

We are grateful to Prof. P. V. Bole of St. Xavier's College, Bombay for placing at our disposal all the specimens of the tribe *Scilleae* extant in the Blatter Herbarium.



Ardisia meghalayensis sp. nov.

A. Habit (natural size); B. Flower bud; C. Calyx lobes; D. Two petals and a stamen; E. (I, II, III, IV, V)—Petals; F. Stamen—dorsal view; G. Stamen—Ventral view; H. Gynoecium.

A new species of *Ardisia* (Myrsinaceae) from north-east India[1]

M. P. NAYAR AND G. S. GIRI
Central National Herbarium, Botanic Garden P.O., Howrah 3
(*With a plate*)

A new species, *Ardisia meghalayensis* from Jaintia hills, Meghalaya, India is described and illustrated.

Ardisia meghalayensis sp .nov.

Affinis *A. blumei* A.DC. sed foliis ad nodis 4-6 confertis, minoribus, 6-8 cm longis, 2.5-3.5 cm latis, inflorescentiis subcorymbosis, pedicellis longioribus differt.

Frutex. *Ramuli* subteretes, juniores ferrugineis, dense pilosi. *Folia* petiolis 8-10 mm longis stipitata, ovato-lanceolata, 6-8 cm × 2.5.3.5 cm, basi cuneata, apice acuta vel acuminata, margina dentato-crenata, chartacea, supra junioris pubescentia, subtus ad nervos adpresse hirsuta, dense glanduloso-punctata, costis supra immersis, subtus prominentibus. *Inflorescentiae* laterales, subcorymbosae, 3-5 cm longae, dense pilosi-hirsutae, foliis breviores; flores hirsuto-pilosi; pedicellis ± 1.5 cm longis, bracteati; bracteae lineares 5-7 mm longae, pubescentes. *Sepala* 5-partita basi ad 1/3 connata, lanceolata, 5-7 mm × 1.1.5 mm, acuminata, ciliata, glanduloso-punctata. *Petala* 5, subsymmetrica, imbricata, basi breviter coalita, ovato-elliptica, 5-6 mm × 4-4.5 mm, glanduloso punctata. *Stamina* 5, petalis paullo breviora, antheris 3-3.5 mm × 1-1.5 mm, acutis filamentis 0.5-0.8 mm longis. *Ovarium* subglobosum, glabrum; stylus 3-4 mm longus, stigmate inconspicuo.
Typus: Meghalaya, jaintia hills J/M No. 903 (CNH Acc. No. 279310) (CAL).

Shrub, Branches subterete, ferruginous and densely pilose when young. Leaves petiolate, petiole 8-10 mm long, ovate-lanceolate, 6-8 cm × 2.5-3.5 cm, basi cuneate, apex acute or acuminate, margin dentate-crenate, chartaceous, upper surface when young pubescent, undersurface along the nerves hairy, densely glandulose punctate, nerves on the

[1] Accepted March 1975.

upper surface immersed, and nerves on the undersurface prominent. Inflorescence lateral, subcorymbose, 3-5 cm long, densely pilose hirsute, shorter than the leaves; flowers hirsute and pilose; pedicel ± 1.5 cm long, bracteate; Bracts linear 5-7 mm long, pubescent. *Sepal* 5 lobed united 1/3 at the base, lanceolate, 5-7 mm × 1-1.5 mm, acuminate, ciliate glandulose-punctate. *Petal* 5, subsymmetrical, imbricate, united shortly at the base, ovato-elliptic, 5-6 mm × 4-4.5 mm, glandulose punctate. *Stamens* 5, shorter than petals, anther 3-3.5 × 1-1.5 mm, acute, filament 0.5-0.8 long. *Ovary* subglobose, glabrous; style 3-4 mm long, stigma inconspicuous.

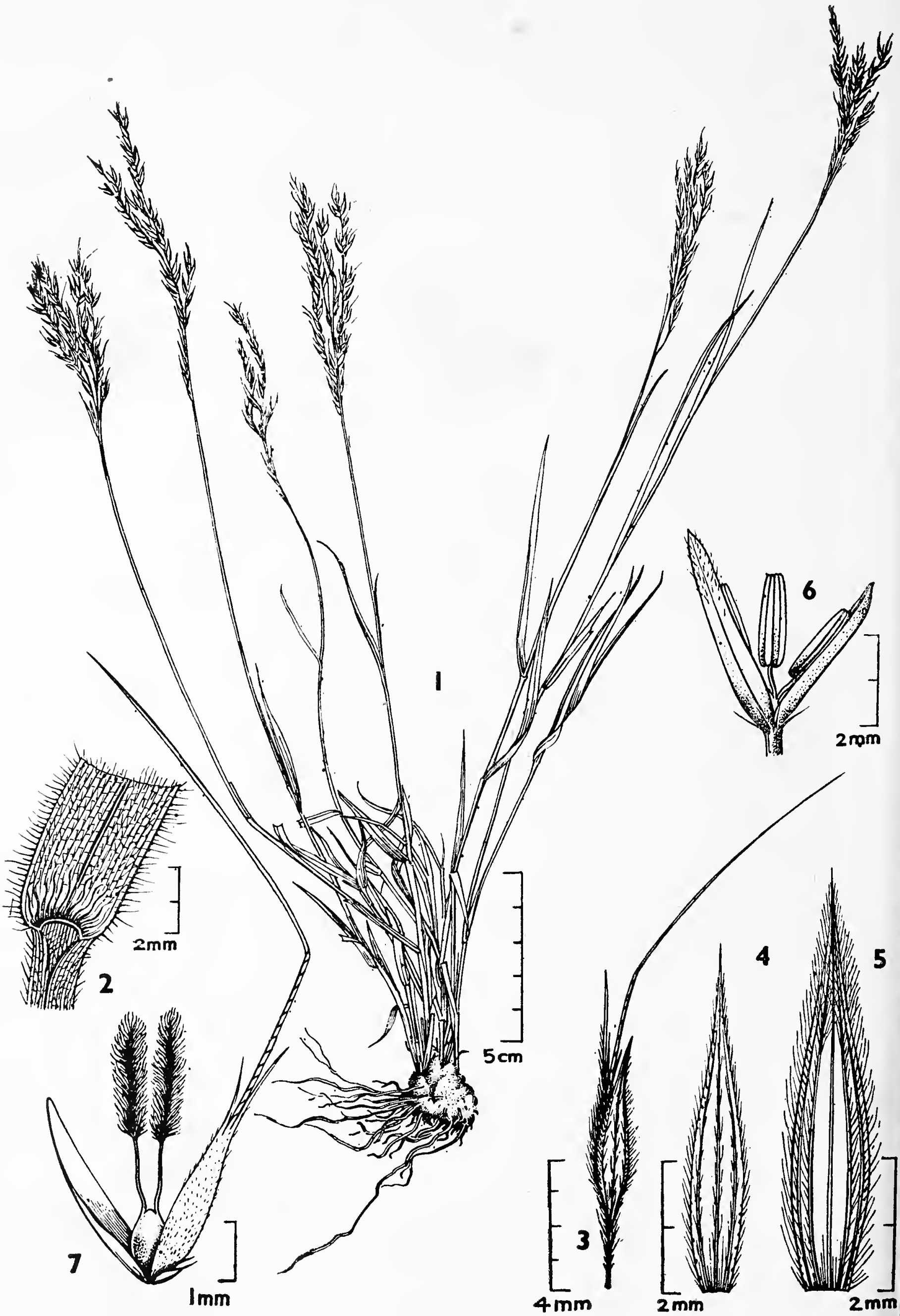
Distribution: INDIA: Meghalaya, Jaintia hills, Pangle woods, alt. 1333-1666 m, May 1878, J/M No. 903 (CNH Acc. No. 279310) (CAL).

Ardisia meghalayensis differs from *A. blumei* A.DC. in having smaller leaves (6-8 cm × 2.5-3.5 cm), subcorymbose, inflorescence and longer pedicel, (1.5 cm long). The presence of 4 to 6 leaves at the nodes is very characteristic in *A. meghalayensis* whereas in *A. blumei,* the leaves are larger (13 cm × 3.5 cm), the inflorescence is paniculate and pedicels are shorter ± 4 mm long.

Acknowledgement

We wish to thank the Deputy Director, Central National Herbarium for all facilities.

Subba Rao & Kumari: *Arundinella setosa* var. *nilagiriana*



Arundinella setosa Trin. var. *nilagiriana* var. nov.
1. Plant; 2. Part of leaf and sheath with ligule; 3. Spikelet; 4. Lower glume; 5. Upper glume; 6. ♂ spikelet; 7. ♀ spikelet.

A new variety of *Arundinella setosa* Trin. from India[1]

G. V. Subba Rao and G. R. Kumari
Botanical Survey of India, Coimbatore
(*With a plate*)

Arundinella setosa Trin. var. **nilagiriana** var. nov.

Accedit ad *Arundinella setosam* Trin. var. *lanigeram* Fischer a quo tamen differt glumis hirsutis.

Holotypus *Subbarao et Kumari* 19795 A et isotypi *Subbarao et Kumari* 19795 B—F a G. V. Subbarao et G. R. Kumari die 11-ix-1970, paratypi vero *Subbarao* 40477A-J a G. V. Subbarao die 25-iii-1972 propinquus Koilbetta (alt. s.n. 1850 m) ad Ebanad in dist. Nilgiri, in Tamil Nadu, lecti sunt. Typus (*Subbarao et Kumari* 19795 A) in herbario Centrali nationali, ad Calcuttam (CAL), isotypi (*Subbarao et Kumari* 19795 B-F) et paratypi autem (*Subbarao* 40477 A-J) in herbario regionis australis Bot. Surv. India ad Coimbatore (MH) positi sunt.

Arundinella setosa Trin var. **nilagiriana** var. nov. (Poaceae—Arundinelleae)

A perennial grass with whitish woolly base, culms up to 30 cm, slender, terete, smooth, almost glabrous, ± striate, erect; nodes glabrous. Leaf blades narrow, linear, tapering to a point, striate, 7.5-9 × 0.2-0.4 cm, hirsute on both sides with tubercle based hairs, ciliate on margins with similar hairs; sheaths clasping the culms, striate, hirsute as leaf blades; ligule very thin, membranous, hairy with long white silky hairs. Inflorescence an erect panicle, 8-12 cm long; axis terete, striate, scabrid; branches 3-6 cm, alternate, distant; pedicels often in pairs, one long-one short, dilated below the spikelet, scaberulous and always with long bristles near the tip. Spikelets 5-7 mm long, gaping. Lower glume 5-6.5 mm long, dark purple in colour, ovate-acuminate, shortly aristate, firm, 3-nerved, nerves anastomosing at the tip, bristly with tubercle based colourless hairs; upper glume 5.5-7 mm long, light yellow, membranous, ovate-cuminate, the upper one third forming a narrow beak clasping the awn, 5 nerved, nerves anastomosing at the tip, pubescent.

[1] Accepted March 1975.

Lower floret ♂; lemma 3-4 mm long, membranous, rounded on the back, oblong-obtuse, keeled, scaberulous without in the upper half; palea elliptic-obtuse, a little shorter narrower and thinner than the lemma, rather flat; stamens 3; anthers 1.5 mm long. Upper floret usually ♀, rarely ☿; lemma 2-2.5 mm long with a hairy callous, shining, scabrid without, lanceolate with a stout twisted awn at the apex in between two colourless scabrid setae; palea almost of the same size and texture; awn up to 7-8 mm long, geniculate, scabrid; column 3 mm long, chestnut brown; stamens 3; anthers 2 mm long; ovary smooth, 1 mm long; styles 2-2.5 mm long; stigmas plumose, 1.5 mm long. Caryopsis not seen.

This taxon is allied to *Arundinella setosa* Trin. var. *lanifera* Fisch. but differs from it in having hirsute glumes.

The holotype *Subbarao et Kumari* 19795 A and isotypes *Subbarao et Kumari* 19795 B-F and paratypes *Subbarao* 40477 A-J were collected respectively by G. V. Subbarao and G. R. Kumari on 11-ix-1970 and by G. V. Subbarao on 25-iii-1972 near Koilbetta (1850 m alt.) at Ebanad in Nilgiri District, Tamil Nadu. The type (*Subbarao et Kumari* 19795 A) has been deposited in the Central National Herbarium, Calcutta (CAL), the isotypes (*Subbarao et Kumari* 19795 B-F) and paratypes (*Subbarao* 40477 A-J) have been deposited in the Regional Herbarium, Botanical Survey of India, Coimbatore (MH).

Acknowledgements

We are thankful to late Dr. N. L. Bor, Kew Herbarium for kindly scrutinising the specimen and giving his valuable opinion and to the Director, Royal Botanic Gardens, Kew for his help. We are also thankful to the Forest Department, Tamil Nadu and the Director, Botanical Survey of India for facilities provided; to Rev. Fr. Dr. K. M. Matthew, S.J., for the latin diagnosis; to Dr. S. K. Jain and Dr. R. B. Majumdar of Botanical Survey of India for scrutinising the specimen and giving their valuable opinion.

Reviews

1. PARCHED EARTH. The Maharashtra Drought 1970-73. By V. Subramanian. pp. 640 (23 × 15 cm). Bombay, 1975. Orient Longman Limited. Price Rs. 75.00.

Parched Earth is a 623 page tome in praise of the achievements of the Government of Maharashtra, the Central Government and the officials of both in dealing with the unprecedented drought in Maharashtra between 1970-1973. The book is garnished with such hyperbole as "The Maharashtra drought between 1970 and 1973 was a period of unprecedented agony as also unparalleled ecstasy"—"Cattle were famished and the old and the decrepit among them perished uncomplainingly"—"Students of schools and colleges unable to pay their tuition and examination fees on account of the penury of their parents or their guardians stood in imminent danger of the ruination of their careers". "Maharashtra's administration rose to new heights of responsibility, performance and compassion. Bureaucracy by its alertness and efforts wiped away the stigma of ages attached to it." Such extravaganza detracts from the vast array of statistics.

Land was bunded, irrigation and percolation tanks were constructed canal excavation was undertaken, roads were built and dole provided to the aged and those unable to work.

It is rather dismaying to see that out of a total expenditure of 252.87 crores only 10.06 lakhs were spent on afforestation including soil and moisture conservation operations, to which the author devotes only two and a half pages. The author writes (p. 149)—"Afforestation occupies a comparatively minor place in the relief programme because the availability of land under forest is very low—.... The area under forest in the districts of Bhir and Osmanabad is less than 5 per cent of the total area of these districts and therefore no major scheme of afforestation could be initiated in these districts." Had this logic been followed elsewhere, Israel would still be a desert and Gujarat, with less than 9 per cent of forest in the state, would not have embarked on an ambitious programme of reforestation as they rightly have.

One of the effects of the drought, the author says, was to create for a while, a classless, casteless society and a spirit of cooperation. Landless labourers began to be aware of their rights as a result of the attention of urban trade union leaders. Medical interns went out into the villages and attended on the people and prevented the rural population from being decimated (*sic*) Boys who had passed their S.S.C. willingly and cheerfully worked as manual labourers.

The author quotes Newsweek that thousands died of starvation in the Sahel countries of N. Africa as a result of drought and remarks "Not a single man, woman or child (in Maharashtra) died of starvation during the entire period of the drought"—and "there was not a single case of epidemic or death by water poisoning."

If all that the author says is true then Maharashtra is not only capable of solving all her problems but also provides an example for the whole of India. One wonders with some trepidation whether a period of continuous drought is necessary to bring out the best in Indians.

There is an interesting example of intermediate technology referring to the use of bullock-drawn rollers for the compaction of percolation tank beds in place of diesel driven rollers. The author says on p. 201 ".... Percolation tanks should not be constructed in regions having less than 15″ of rainfall, as they would have little chance of filling up." This statement is debatable (like the one on reforestation referred to earlier) as percolation tanks have been successful in rain-shadow areas of Maharashtra like Naigaon, Poona District. In Saurashtra, which receives little rain normally, the foresight of the people in having excavated tanks has enabled them store a lot of water during the recent torrential rains there and this will meet their requirements for a couple of years if not more.

The following public organisations helped the Maharashtra Government in drought relief work.

Catholic Relief Services—covered 8894 projects, 346 426 workers employed. 28,000 tonnes wheat costing 27.4 crores and 1,340 tonnes of oil costing 5.19 crores were supplied. Front for Rapid Economic Advancement of India (FREA) supplied technical manpower to survey, design, supervise works in Paloda, Taluk of Bhir District, cooperated with CARITAS (India) in the programme of distribution of milk. OXFAM (UK registered) assisted on a nutritional programme—provided to Maharashtra a large percentage of its total worldwide contribution. Tata Relief Committee helped with irrigation, drinking water, planting fruit trees and in association with CASA supplied food both for people and cattle. Youth Against Famine Campaign—This was launched jointly by the Government of India and several voluntary agencies to get 100,000 young men and women from schools and Universities to participate. 100 camps were organised and the campaign was conducted by a special committee of the NSS in Maharashtra State (8,000 students and 2,000 non-student participants). Dnyana Prabodhinee—an educational institution, SARRAM (Society for Assistance, Rehabilation, Relief & Aid Maharashtra), Shri Sadguri Seva Sanch were other organisations which also assisted.

Appendices include tables showing areas under principal crops, agricultural production, release of Central Government monetary assistance,

daily labour attendance on relief work, workwise expenditure, statewise comparison of kilometres of road per 100 sq km of area. (Punjab and Kerala, incidentally, head the list with close to 150 km; Maharashtra has 26.8 km and Meghalaya has the lowest, 22. However, if km/100,000 population is considered, Meghalaya heads the list with 1,028 km followed by Punjab which has 557. Maharashtra has 164 and the lowest on the list is Haryana with 130). There are several pages of tables showing the number of scarcity relief works, average daily labour attendance as well as expenditure incurred during 1970-71, 71-72, 72-73, and 73-74. These are given districtwise for the 25 districts in Maharashtra. Separate tables are similarly provided stating physical achievements. There are monthly price indices for urban and rural areas, statements showing retail prices of essential commodities in rural, scarcity and other areas of the State during the period June 1972 to October 1973 and finally, rainfall charts.

The author has not been punctilious in following the metric system throughout which is now statutory in India. On p. 212 there is a mixture of millimetres, feet and inches "58 mm dia bore holes drilled to depths of 50 to 60 feet—4″ to 8″ dia bore holes etc."

The book is too voluminous and at Rs. 75 is not likely to attract buyers. Busy administrators will not be able to do more than skim through it. It would have been better if the material had been condensed into a brochure with the purpose of circulating it as a case study for administrators as well as providing publicity for the Government.

G.S.R.

2. A DICTIONARY OF THE FLOWERING PLANTS IN INDIA. By H. Santapau and A. N. Henry. Assisted by Bela Roy and Partha Basu. pp. viii + 198 (24.5 × 16 cm). New Delhi, 1973. Publication and Information Directorate. Council of Scientific and Industrial Research. Price Rs. 22.00, £ 3.50, $ 9.00.

This is a publication designed for use by educated laymen in India and as a preliminary ready reference for those interested in Indian flora and the country's plant resources.

The Dictionary gives 2890 Generic names of Indian plants. Under each genus, the information given includes its habit, total number of species found in the world and in India. One or two well known species of each genus have been named. Local or regional vernacular names are given in many cases along with reported uses, if any. Some of the generic valid names vary from those published in Indian floras, however the synonyms are listed under the valid name as well as separately, at appropriate places with cross reference to the new name accepted in the Dictionary. Abbreviations used in the dictionary are listed and refer-

ences provided. The scheme of distribution of the genera is explained in the preface.

This valuable publication from the staff of Botanical Survey of India should find a place in any botanical and general library in India, as a ready reference handbook.

P.V.B.

3. THE INSECT SOCIETIES. By Edward O. Wilson. pp. x + 548 (25.5 × 20.5 cm). With numerous black and white figures and line drawings. Third Printing. Massachussetts, 1974. The Belknap Press of the Harvard University Press, Cambridge. Price $ 7.95.

This book represents the first synthesis and summarisation of recent knowledge about these fascinating insects since W. M. Wheeler wrote his classic "The Social Insect" in 1928. A glance at the bibliography will give an idea of the magnitude of the task, for the problems associated with the understanding of insect societies have attracted many research workers and various lines of enquiry.

The author gives us a comparative account of the life histories of the wasps, bees, ants and termites, their symbionts and parasites, their methods of communication and caste determination, subjects about which so much is known and so much yet remains to be determined.

The questions to be answered are many. Why, for instance, has social behaviour evolved so many times in the Order Hymenoptera and only once among other insect orders? Pre-social behaviour such as communal nesting and quite advanced parental care is fairly common among species of bugs, beetles, crickets and spiders. There are even species like western tent caterpillar (*Malacosoma pluviale*), which show division of labour in feeding aggregations.

How can the complex problems of recognition and communication in a community be solved by the insect brain with its limitations of size? Are social insects more intelligent than solitary ones? This is difficult to answer, since almost all experiments work has been done on social insects. Strong differences in maze running abilities have been found between different castes of ants, and even between individuals belonging to the same caste. However, Dr. Wilson believes that among the Hymenoptera at least, solitary wasps are capable of behaviour as complex as that of social species.

Wheeler believed that an insect society should be regarded as a "superorganism", with its members functioning like organs rather than as individuals. However, modern workers find it more useful to study them as social animals which are organised very differently from social vertebrates. The evolution of insect societies shows special features, since the selection pressures which produced the sterile castes have to

operate through the reproductive castes. The mature insect colony can be expected to contain the ratio of different castes that can achieve the maximum rate of production of reproductive castes. The study of why these ratio vary between species and in different environmental conditions is an interesting new field.

Anyone interested in social insects, or planning any research on them, will, for many years to come, have to refer to this authoritative book.

R.R.

4. SARPA PARICHAYA. By Ramesh Kankonkar. pp. 116 (21 × 13.5 cm). With twenty text-figures and eight plates. Bombay, 1974. Somaiya Publications Pvt. Ltd. Price Rs. 17.00.

The book is aimed at imparting knowledge on the Science of Ophiology to the lay, non-technical public in the State. In the past there have been from time to time translations of articles and works of eminent ophiologists in Marathi literature but in view of the fact that fresh knowledge has been added over years by various workers in the field, publication of a volume as the one under review, collating all the accumulated knowledge is welcome. One other task the book has set upon is an attempt to remove many time-old fallacies which have crept in the folklore over the ages, and to present snakes to the laymen in their true perspective. We have very little knowledge of the habits of snakes in the wild. Yet there are several stories about their extraordinary and at times supernatural behaviour. It is wise to decide to believe nothing one hears about snakes, and only half of what one sees oneself, guarding carefully against the possibility of one's visual impressions being influenced by one's expectations and preconceived notions.

The author has achieved much by extracting information from all the literature at his disposal, and his personal experience, and presenting it in the book in a most simple and clear manner. The text is free from technical jargon attendant to scientific works and transliterations and should be of help and interest to the most uninitiated in the subject.

In all 40 species are treated in the book, but considering that there are around 52 species in Maharashtra, one wishes that the author had enlarged the scope of this book to cover all the ophidian species met with in the state at least.

Text figures and plates are clear and informative. The bibliography at the end of the book is a useful item.

Somaiya Publications deserve to be congratulated in adding one more publication by way of this book to the existing Marathi literature.

S.R.G.

5. DEFENCES OF ANIMALS. By David Boston. pp. 60 (18.5 × 12.5 cm), with 24 illustrations. London, 1972. The Inner London Education Authority. Price 25 p.

This small handbook is primarily meant as a guide to the exhibits in London's Horniman Museum. The book is however written in a manner that makes it useful as an aid to teachers for nature study in schools.

Survival in nature is the main function of all animals. Many ways have been evolved by animals through natural selection to protect themselves from adverse environmental conditions. The defences are basically of two types, internal defence mainly dependent on the physiology of the animal or plant where a series of antidotes are produced in the case of infection, injury etc. The obvious external defence is the skin and its modifications. The book describes various defensive measures and each function is neatly categorised with suitable examples of exhibits and photographs. The mode of defences are divided according to their functions, such as surface protection, actions, mimicry, weapons and coloration. Each action and modification is briefly described by citing living or extinct examples from the animal Kingdom.

This book creates an awareness of the wonderful intricacies of nature at work, to protect its denizens and underlines the gravity of man's responsibility in maintaining proper balance.

S.A.H.

6. ABIES AND PICEA. By K. A. Chowdhury. pp. viii + 46 (24 × 16 cm), with 41 text-figures. New Delhi, 1974. Publications & Informations Directorate. Council of Scientific and Industrial Research. Price ?

This publication forms No. 9 in the series of Botanical monographs published by the Council of Scientific and Industrial Research, New Delhi, 12 (India). It embodies the morphological studies of the two genera. Six Indian species of the two genera (*Abies pindrow, A. spectabilis, A. densa* and *A. delavayi* and *Picea smithiana* and *P. spinulosa*) are described in detail. Morphology and anatomy of root, shoot, leaf, cones, embryology and seed, and cytological studies are reported. The diseases and economic uses are also given. It includes extensive list of literature cited.

The publication maintains the excellent standard of the series. It will be useful to students of gymnospermous plants.

P.V.B.

7. THE WILD FERNS OF MADRAS CITY AND ITS IMMEDIATE NEIGHBOURHOOD. By M. S. Chandrasekhar. Vol. VIII, No. 1. New Series. pp. 70 (29 × 25 cm), with 25 plates. Madras, 1972.

Bulletin Government Museum, Madras (Natural History Section). Price Rs. 7.10.

This is a welcome addition to the knowledge of local ferns of Madras City and certainly would serve local interests.

The text contains elaborate descriptions of 19 species of ferns, including detailed diagnosis of the higher taxa starting from "Plant Kingdom". Out of 19 species described author has collected 16 himself, mostly from Kabakum village (762 m altitude). One was seen in the herbarium of a local college and two more are taken from earlier published reports.

This publication contains two original contributions from the author (1) the artificial Key for identification of 19 species of ferns. (2) their Tamil names. In addition, the author has presented Pichi-Senmoli's Classification of Pteridophyta which is confined to the 19 species under reference and therefore limited in its use. The 25 plates in the volume are in no way better than Beddome's ferns of Southern India.

Considerable changes appear to be necessary in the nomenclature of the species in view of the information available in monographs and other critical studies e.g.:

(1) *Ophioglossum reticulatum* L. has been noted as synonymous with *O. nudicaule* L.f. Almost every monographer of this genus has treated them as two distinct species.

(2) *Lygodium microphyllum* R. Br. is noted as synonymous with *L. scandens* (L.) Sw. Holtum has shown it to be a distinct species (See Flora Malasiana *2*(1):47, 1963).

(3) *Adiantum caudatum* L. appears with four synonyms: *A. hirsutum* Bory. *A. ciliatum* Bl., *A. incisum* Forsk. and *A. capillus* Webb. According to Ghatak, the plant appears to be *Adiantum ciliatum* Bl. and all the species cited in the synonymy are distinct taxa. (See, Bull. Bot. Surv. India, *5*(1):71-77, 1963).

(4) *Schizolepton* Fee. is shown to be a synonymous with *Lindsaya* Dry. ex J. Sm. (Lindsayaceae). Actually it belongs to the family Gymnogrammaceae and probably allied to *Taenitis* Willd. (See Amer. Fern Jour. 50:109-113, 1960).

(5) *Diellia* Brack. is also shown synonymous with *Lindsaya* Dry. It is placed in the family Apleniaceae by Wagner. (See Univer. Calif. Publ. Bot. 26:1-212, 1952).

(6) *Pleopeltis* Humb. et Bonpl. is shown to have the following synonyms:

1. *Microsorium* Link. (See, Bir and Trikha, Bull. Bot. Surv. India, 10(2):133-148, 1968).
2. *Tectaria* Cav. (A genus belonging to family Aspidiaceae).
3. *Marginaria* Bory. (Genus synonymous with *Polypodium* L.).
4. *Microgramma* Presl. (another valid genus).

Considering its price it is certainly worth acquiring by plant lovers of Madras and other parts of India.

M.A.

Miscellaneous Notes

1. RECORD OF THE BAT *SCOTOPHILUS TEMMINCKI* HORSFIELD (VESPERTILIONIDAE) FROM RAJASTHAN

The bat, *Scotophilus temmincki* Horsfield, although wide spread in India has hitherto not been recorded from Rajasthan. Recently I obtained a female from eastern Rajasthan (P.W.D. Rest House, Bharatpur on 17-x-1973, at night between 8 and 10 p.m. in a mist net). Colour of fur: rufous brown above, dirty white below. Measurements (in mm) as follows:

Head and body, 66; ear, 15; tragus, 7; tail, 42; tibia, 19; foot including claws, 10; fore arm, 50.

Skull: Total length, 18.2; zygomatic width, 12.5; cranial width, 9; maxillary width (m^3–m^3), 8.3; canine width (c^1–c^1), 6; length of upper tooth row (c–m^3), 6.5; length of lower tooth row (c–m_3), 7.2; mandibular length, 13.5.

According to Ellerman & Morrison-Scott (1951, p. 178-9)[1] *S. temmincki* is an oriental species with five subspecies of which *S. t. wroughtoni* alone occurs in India.

DESERT REGIONAL STATION, Y. P. SINHA
ZOOLOGICAL SURVEY OF INDIA,
PAOTA, JODHPUR,
January 24, 1974.

2. MATERNAL BEHAVIOUR OF A DESERT GERBIL

One fine evening, early in July 1974, at about 6 p.m., my son watering our kitchen garden at our house in the Central Arid Zone Research Institute, Jodhpur campus, was alarmed by a peculiar noise caused by movements of some small animals fighting in the dried leaves of the *Lantana* hedge. A snake emerged out of the hedge and started climbing it. Surprisingly, the snake was being chased by a Desert Gerbil. We observed the rodent quickly biting the tail of the snake which was later identified as *Coluber* sp. I hit the snake with a stick and as it struggled, a newborn Gerbil dropped from the mouth of the snake. The mother

[1] ELLERMAN, J. R. & MORRISON-SCOTT, T. C. S. (1951): Checklist of Palaearctic and Indian Mammals, British Museum (Nat. Hist.), London.

Gerbil which was watching nearby quickly dashed in and picked up its offspring by the 'neck grip' and retired with it into a nearby burrow.

On examination of the dead snake, it was found that about 15 cm of its tail had been badly 'mauled' by the Gerbil.

The whole incident reflects a strong maternal bond in the Desert Gerbil for its young even at the risk of its own life.

CENTRAL ARID ZONE RESEARCH INSTITUTE, JODHPUR, K. D. MUTHANA
October 4, 1974.

3. NESTING BEHAVIOUR OF *MUS MUSCULUS BACTRIANUS* BLYTH IN THE LABORATORY

(*With a text-figure*)

Information on nesting behaviour of *Mus musculus bactrianus* Blyth is meagre and therefore the present study was undertaken. Seven pairs of mice were kept for 5 to 6 months in cages before the start of the experiments, to acclimatize them to laboratory conditions and to one another. They were provided with 2 nest-boxes one in each half of the cage. Rice straw was provided at weekly intervals for building nests. The straw used for nest-building, either inside or outside the nest-box, was removed daily and weighed after clearing the nest-boxes and counting the nests. The nesting behaviour was studied from January to May and during the reproductive cycles.

1. *Nesting behaviour in different months*:

(i) *Nesting efficiency*: The nesting pairs of the mouse used variable amounts of rice-straw for nest-building and the number of nests also varied from month to month, the variation being highly significant. The mean amount of nesting material used per day by one pair ($n = 7$) decreased from 4.536 g in February to 28 mg in May (Table 1). Similarly, the mean number of nests built per day per pair decreased from 1.05 in February to 0.05 in May (Table 2).

Thus it is clear that as the season warmed up, the frequency as well as the efficiency for nest-building decreased considerably. Denenberg *et al.* (1969)[1] reported that when male and female rats were exposed to cool ambient temperatures, dowel-shredding for nest-building increased markedly, whereas the exposing of the females to a warm environment stopped the dowel-shredding behaviour.

(ii) *Nesting site*: There were only 2 options for the mice to build

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[1] DENENBERG, V. H., TAYLOR, R. E. & ZARROW, M. X. (1969): Maternal behaviour in the rat. An investigation and quantification of nest building. *Behaviour, 34*:1-16.

the nest, namely inside the nest-box or outside it. The mean (n = 7) amount of rice-straw used per pair per day over a 5-month period was 1.455 gm in case of nests built inside the nest-box against 0.805 gm when the nests were built outside it (Table 1). Further, the mean number of nests built per day per pair in the nesting boxes was 0.45 against only 0.23 outside it (Table 2).

TABLE 1

AMOUNT OF NESTING MATERIAL USED BY *Mus musculus bactrianus* BLYTH FOR BUILDING NESTS

Location of the nest	Nesting material* (g/day/pair) used in					Average/ day (g)
	Jan.	Feb.	March	April	May	
1. Inside the nest-box	1.907	3.242	1.080	1.023	0.019	1.455
2. Outside the nest-box	1.389	1.294	0.806	0.528	0.009	0.805
Total	3.296	4.536	1.886	1.551	0.028	2.260

	C. D.	
	p = 0.05	p = 0.01
Main-treatments (months)	0.05	1.11
Sub-treatments (Location of the nest)	0.18	0.25
Interaction (Main-treatment × Sub-treatment)	0.43	0.57

* Mean of 7 pairs.

TABLE 2

FREQUENCY OF NEST BUILDING BY *Mus musculus bactrianus* BLYTH

Location of the nest	Number* of nests/day/pair					Average/day (no.)
	Jan.	Feb.	March	April	May	
1. Inside the nest-box	0.55	0.72	0.59	0.36	0.04	0.45
2. Outside the nest-box	0.33	0.33	0.31	0.18	0.01	0.23
Total	0.88	1.05	0.90	0.54	0.05	0.68

	C. D.	
	p = 0.05	p = 0.01
Main-treatments (months)	0.09	0.13
Sub-treatments (Location of the nest)	0.09	0.12

* Mean of 7 pairs.

Thus both the number of nests and the weight of the material used in making them show that the mouse prefers to build the nest inside a sheltered area. In winter, they preferred to build nests inside the nest-boxes, whereas in the summer there was no site preference.

2. *Nesting efficiency during reproductive cycles*:

The amount (mean of 7 parturitions) of rice-straw used was 2.717 gm (n = 29), 6.136 gm (n = 10) and 2.171 gm (n = 11) per day during pre-parturition, parturition and post-parturition respectively. The nesting efficiency was highest (p = 0.01) at or just before parturition. Before it, the nesting efficiency increased abruptly, whereas afterwards it declined slowly (Fig. 1). Denenberg *et al.* (1969) reported that in rats,

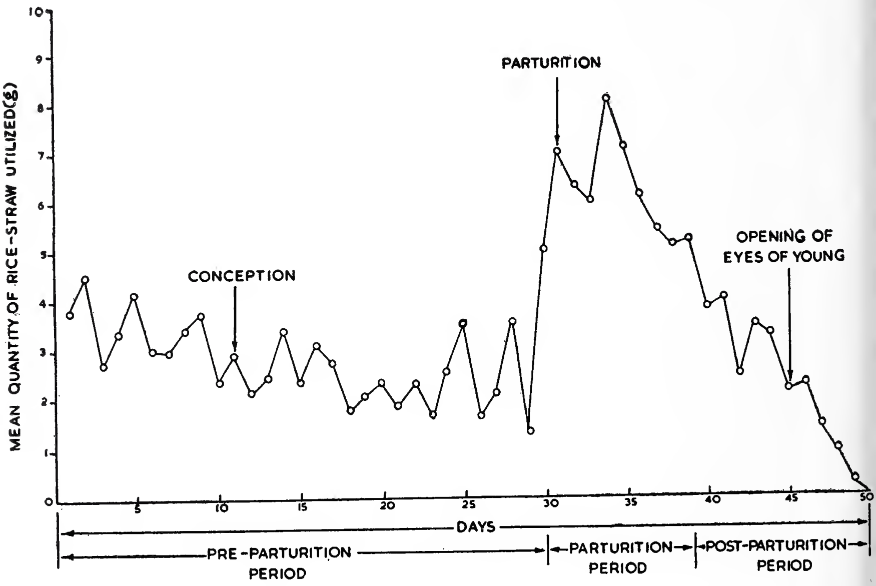

Fig. 1. Amount of rice-straw utilized daily by *Mus musculus bactrianus* Blyth. (mean of 7 parturition).

pregnant females showed a marked increase in dowel-shredding at or just before the time of parturition, and it fell slowly after parturition. He further mentions that males and non-pregnant females did not show such a pattern over an equivalent period. The nest-building behaviour has survival value for the young.

DEPARTMENT OF ENTOMOLOGY,
PUNJAB AGRICULTURAL UNIVERSITY,
LUDHIANA,
June 12, 1975.

G. S. MANN
O. S. BINDRA

4. A NOTE ON INTER-PARTURITION INTERVAL OF SOME CAPTIVE WILD MAMMALS

A sound knowledge of all aspects of reproduction including inter-parturition interval of mammals is necessary for their successful breeding in captivity. It is also necessary for the successful planning of breeding programmes in Zoological Parks. Available literature revealed that there are not many reports on this subject. In this communication an attempt is made to present some information on inter-parturition interval observed among five species of wild mammals at Nandankanan Biological Park, Orissa during the period from 29-xii-1960 to 31-x-1973.

Observations and discussion

African lion (*Panthera leo*)

The details of inter-parturition interval observed in two females of this species are given in Table 1.

Table 1

Name of the lioness	Date of last parturition	Date of subsequent parturition	Inter-parturition interval	Period of separation of the female from the male from the date of last parturition mentioned in col. 3
"Chandrakanti"	26.iii.1967 (1st parturition)	17.vi.1969	2 years, 2 months and 21 days	About 18 weeks
,,	17.vi.1969	9.xi.1970	1 year, 4 months and 22 days	About 6 months
,,	9.xi.1970	3.iv.1971	4 months and 24 days	1 day
,,	3.iv.1971	30.x.1972 (5th parturition)	1 year, 6 months and 26 days	About 5½ months
"Vijayanti"	8.ii.1970 (1st parturition)	19.vii.1970	5 months and 10 days	About 1 month
,,	19.vii.1970	20.x.1971	1 year and 3 months	About 16 weeks
,,	20.x.1971	17.ix.1973 (4th parturition)	1 year, 10 months and 27 days	About 5 months

From this table it can be seen that the inter-parturition interval observed in seven cases among two lionesses varies from 4 months and 24 days to 2 years, 2 months and 21 days with an average of 1 year, 3 months and 23 days. One female gave birth to five litters in a period of 5 years and 8 months whereas another female gave birth to 4 litters in a period of 3 years and 8 months. The minimum intervals of 4 months and 24 days (144 days) and 5 months and 10 days (160 days) were

possible as the females lost their cubs and were allowed to remain with the males within about one day and one month respectively from the date of last parturition.

Young are produced at intervals of at least 18 months to 2 years (Prater 1971). Asdell (1964) states that two litters may be born in a year. Most cats have one or two litters a year, the larger species sometimes breed only every two or three years (Walker *et al.* 1964).

TIGER (*Panthera tigris*)

The details of inter-parturition interval observed in two females of this species are given in Table 2.

TABLE 2

Name of the tigress	Date of last parturition	Date of subsequent parturition	Inter-parturition interval	Period of separation of the female from the male from the date of last parturition mentioned in col. 3
'Sikha'	30.xii.1966 (1st parturition)	31.vii.1967	7 months	About 1 month
,,	31.vii 1967	10 iv.1971	3 year, 8 months and 9 days	About 7½ months (The female was kept separately from the male frequently as they fought)
,,	10.iv.1971	14.xii.1972 (4th parturition)	1 year, 8 months and 3 days	About 9 months
'Rani'	7.xi.1971 (1st parturition)	2.iv 1972	4 months and 25 days	25 days
,,	2.iv.1972	22.vi.1973 (3rd parturition)	1 year, 2 months and 19 days	About 9 months

From this it can be seen that the inter-parturition interval observed in five cases among two tigresses varies from 4 months and 25 days to 3 years, 8 months and 9 days with an average of 1 year, 6 months and 5 days. One female could produce 4 litters in about 6 years whereas another could produce 3 litters in 1 year and 8 months. The minimum intervals of 7 months and 4 months and 25 days (164 days) could be possible as the females lost their cubs and were allowed to remain with the males within about 1 month and 25 days respectively from the date of last parturition.

Most cats have one or two litters a year, the larger species sometimes breed only every two or three years (Walker *et al.* loc. cit.). In the wild the interval between two successive cubbings is about three years (Chaturvedi 1970). One tigress of New York Zoological Park produced 11 litters during the period from 1948 to 1959 and that park was in the practice of weaning the tiger cubs when they were between 3½ and

4 months old (Crandall 1965). According to Schaller (1972) in Zoos, where the cubs are usually removed from the mother at birth, one litter per year is common. At London Zoo a tigress had 8 pregnancies between 1961 and 1964 including 3 births recorded to this female during 1962 (Schaller loc. cit.). Schaller further states that a free living tigress that loses her cubs in some mishap is able to have a new litter within about 5 months.

LEOPARD (*Panthera pardus*)

The details of inter-parturition interval observed in three females of this species are given in Table 3.

TABLE 3

Name of the leopardess	Date of last parturition	Date of subsequent parturition	Inter-parturition interval	Period of separation of the female from the male from the date of last parturition mentioned in col. 3
'Sundari'	9.iv.1967 (1st parturition)	1.xii,1968	1 year, 7 months and 21 days	About 8 months
,,	1.xii.1968	4,vi.1969	6 months and 2 days	4 days
,,	4.vi.1969	31.v.1970	11 months and 26 days	About 14 weeks
,,	31.v.1970	3.viii.1971	1 year, 2 months and 2 days	About 14 weeks
,,	3.viii.1971	20.i.1973 (6th parturition)	1 year, 5 months and 16 days	About 8 months
'Rupa'	12.vi.1969 (1st parturition)	2.xi.1970	1 year, 4 months and 20 days	About 3 months
,,	2.xi.1970	22,iv.1972	1 year, 5 months and 19 days	About 13 weeks
,,	22.iv.1972	2.viii.1973 (4th parturition)	1 year, 3 months and 10 days	About 5 months
'Spotty'	20.i.1971 (1st parturition)	18.vi.1972	1 year, 4 months and 28 days	About 6 months
,,	18.vi.1972	23.vii.1973 (3rd parturition)	1 year, 1 month and 4 days	About 6 months

From this table it can be seen that the inter-parturition interval observed in ten cases among three female leopards varies from 6 months and 2 days to 1 year, 7 months and 21 days with an average of 1 year, 2 months and 27 days. One female produced 6 litters in a period of 5 years and 10 months; a second female produced 4 litters in a period of 4 years, and 2 months whereas a third female produced 3 litters in a period of 2 years and 7 months. The minimum interval of 6 months and 2 days (184 days) was possible as the female was allowed to remain with the male within 5 days from the date of last birth.

A panther produced 3 litters in 3½ years in captivity (Prater loc.

cit.). Walker *et al.* (loc. cit.) state that most cats have one or two litters a year, the larger species sometimes breed only every two or three years.

NILGAI (*Boselaphus tragocamelus*)

The details of inter-parturition interval observed in three female nilgais are given in Table 4.

TABLE 4

Particulars of famale Nilgai	Date of last parturition	Date of subsequent parturition	Inter-parturition interval	Remarks
Nilgai "A"	5.ii.1966 (1st parturition)	11.ii.1967	370 days	The females remained with the adult males along with there young throughout the period of observation.
,,	11.ii.1967	13,iii.1968	395 days	
,,	13.iii.1968	16.iii.1969	367 days	
,,	16,iii.1969	30 i.1970	319 days	
,,	30.i.1970	26.xi.1971	664 days	
,,	26,xi.1971	1.ix.1973 (7th parturition)	644 days	
Nilgai "B"	31.xii.1970 (1st parturition)	12.ii 1972 (2nd parturition)	407 days	
Nilgai "C"	1.iv.1971 (1st parturition)	16.ii.1972 (2nd parturition)	320 days	

The inter-parturition interval observed in eight cases among the three females varies from 319 days to 664 days with an average of 436 days. One female produced 7 litters in a period of 7 years and 8 months.

The nilgai breeds immediately after dropping the calves (Asdell loc. cit.).

BLACKBUCK (*Antilope cervicapra*)

The details of inter-parturition interval observed in six cases among three females of this species are given in Table 5.

TABLE 5

Particulars of doe	Date of last parturition	Date of subsequent parturition	Inter-parturition interval	Remarks
Blackbuck "A"	20.ii.1972	6.ix.1972	198 days	The does and young remained with adult males throughout the period of observation.
Blackbuck "B"	22.ii.1972	9.ix.1972	199 days	
,,	9.ix.1972	25.iii.1973	196 days	
,,	25.iii 1973	9.x.1973	197 days	
Blackbuck "C"	25.viii.1972	8.iii.1973	194 days	
,,	8.iii.1973	23.ix.1973	198 days	

From this table it can be seen that inter-parturition interval observed in this species varies from 194 days to 199 days with an average of

197 days.

In England the blackbuck breeds twice a year (Asdell loc. cit.). One fawn per year appears to be the rule among blackbuck (Schaller loc. cit.). According to Taibel (1937) one captive doe gave birth to 6 single fawns between June, 1931 and May, 1935 and another to 5 fawns between October, 1933 and February, 1937, less than a year elapsing between some births.

ACKNOWLEDGEMENTS

We are grateful to Shri D. N. Choudhury, I.F.S., Chief Conservator of Forests, Orissa, Cuttack and Shri S. N. Das, I.F.S. Conservator of Forests, Development Circle, Cuttack for the facilities provided.

VETERINARY ASST. SURGEON, L. N. ACHARJYO
NANDANKANAN BIOLOGICAL PARK,
P.O. BARANG,
DISTT. CUTTACK.

WILD LIFE CONSERVATION OFFICER, R. MISRA
OLD SECRETARIAT BUILDINGS,
CUTTACK-1,
December 17, 1973.

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5. OCCURRENCE OF THE BRAHMINY DUCK (*TADORNA FERRUGINEA*) IN COIMBATORE DISTRICT

A Brahminy Duck was shot by my son on 10-xi-1974 in the Big Tank at Udumalpet about 45 miles south of Coimbatore Town, from a small flock of eight ducks which were found in shallow water near the edge of the Tank.

This is the first authentic instance, of Brahminy Duck being sighted and shot in Coimbatore District. The duck weighed 3 lbs. It had no black ring round the neck.

About the edible qualities of this duck, opinions differ, true to the maxim "One man's meat is another man's poison." As the first bird seen and collected here and to ascertain the fact whether it is fit or unfit for the table, it was plucked and cooked (though I advised skinning). It was extremely fishy and uneatable. The bird had fed on green algae, its beak, mouth, throat and gullet were all full of green algae, emitting a bad odour. On 17-xi-1974 another duck was shot from the same Tank. This was also without the black necklace and weighed only 2½ lbs. It was skinned and cooked and was fair and quite eatable.

On 22-xi-1974 two more ducks weighing 1 Kg. each, were shot. These also had no black ring round the neck. One of these was skinned, cleaned and hung up for a night and then cooked the next morning. It was very good with no fishy odour at all.

18, Perumal Koil Street, B. SUBBIAH PILLAI
Fort,
Coimbatore 641 001,
December 18, 1974.

6. ON THE OCCURRENCE OF THE REDNECKED PHALAROPE (*PHALAROPUS LOBATUS*) ON INLAND WATERS IN BANGALORE

On 30th October 1973, during a session of wader photography from a hide, I noticed a phalarope in the company of wagtails, sandpipers, plovers and stints, feeding on marshy ground adjoining a nearby farm.

The bird was extremely wary and did not approach the hide as closely as did the other birds. It was identified as the Rednecked Phalarope *Phalaropus lobatus* by its fine, blackish bill, dark striped mantle, and the black legs. The white wing-bar noticeable in flights was not seen due to the lack of all-round vision from my hide.

The bird, though it did not seem averse to feeding on the mud-bank with the other birds, seemed to prefer to feed in a small whirpool of water caused by a waste-outlet pipe discharging into one of the small pools. The bird was unusually wary in relation with my past experience of the bird in Scandinavia, and did not come closer than thirty feet from my camera, permitting only a distant 'record' photograph.

The bird was again seen the following day, and four days later on 4th November, though never again after that date. During flight, the bird showed a wing pattern similar to that of a Little Stint, a dark upperpart with a noticeable wing bar.

All observations were made through a 500 mm telephoto lens, and a 10 × 50 field glasses.

163, Domlur Layout, SATISH S. MENON
Bangalore 560 007,
June 22, 1974.

7. CROW-PHEASANT AND FINCH-LARKS

Last summer, while observing partridges with their broods I happened to see a crow-pheasant sitting on the ground and ducking its head to escape the insistent aerial attacks of a female finch-lark. The crow-pheasant had something in its bill and finch-lark was trying to rout the intruder.

When I moved towards them, the crow-pheasant flew away with its morsel followed by the finch-lark in hot pursuit.

Nearing the spot. I saw a fresh nest on the ground, with a dead, partially plucked male finch-lark lying in it. It had a gaping wound on its head through which the brain was bulging out. By its side there was a lifeless nestling.

A. J. College, A. J. T. JOHNSINGH
Sivakasi,
August 2, 1974.

8. A NOTE ON THE SWIFTLETS (*COLLOCALIA*) FOUND IN BURMA

The systematics of this group have for a long time been confused, because morphological differences between species are unobtrusive and, in extreme cases, may even be undetectable. The review by Lord Medway ("Field characters as a guide to the specific relations of swiftlets". *Proc. Linn. Soc. London* 177, 2:151-172. 1966) and earlier papers by the same author have cleared up most of the problems in the group. The account given in THE BIRDS OF BURMA 2nd edition (1953) is now out of date, and needs to be revised as indicated below.

Two characters of the living bird, not normally available to the museum worker, have proved of great taxonomic value.

The first is the ability to orientate acoustically by means of echo-location. When in flight in darkness or poor light those species possessing the faculty utter a penetrating rattle-like call, composed of an irregular succession of brief clicks, invariably audible to man. *C. esculenta* does not utter this call, but all the other Burmese species probably do,

though this still has to be positively recorded for most of the subspecies involved.

The second character is the type of nest built. Swiftlets characteristically build a 'bracket-shaped' nest, in the form of a hanging half-cup in which extraneous nest material is held together by a more or less copious application of 'nest-cement' produced by the bird's own salivary glands. Three main types of nest are built: the 'vegetable' or 'mossy' nest, the 'white' nest, and the 'black' nest: and these are described in more detail below. In different parts of south-east Asia all three types may be commercially exploited as a source of raw material of 'bird's nest soup', the chief constituent of which is the edible nest-cement; but it is the 'white' nest, requiring minimal cleaning and preparation before being cooked, that is by far the most valuable. In Burma this is made only by the species *fuciphaga* in the Mergui Archipelago.

Hmalayan Swiftlet

Collocalia brevirostris (McClelland), Assam
Subspecies: *brevirostris* (McClelland), Assam
rogersi Deignan, Thailand

IDENTIFICATION A large swiftlet, wing 123-142 mm. Tarsus lightly feathered or unfeathered. Tail markedly forked: the difference in length between the long outer feathers and the short central ones generally exceeds 15 per cent of the length of the former. In the nominate race the rump is brownish-grey, clearly differentiated from the blackish-brown of the rump and mantle. The rattle call is probably uttered, but so far positively recorded only for the Javan subspecies.

NEST AND EGGS Livesey found the subspecies *rogersi* breeding in great numbers in the Shan States in deep fissures in the ground, generally in the dip between hilltops at about 4,000 feet. Two eggs were taken on 23rd April. The nest has not been described from Burma, but in the Himalayas and Sumatra is of the vegetable type.

STATUS AND DISTRIBUTION Himalayas, Burma, Thailand, Indochina, south-central and western China; also resident in Java and Sumatra, but only a winter visitor in Malaya. A bird of the higher hills, normally breeding from 4,000 feet upwards. Large flocks have been seen at Gangfang in the Ngawchang valley from November to March, usually at dusk, and breeding in the locality is suspected; also seen in the Adung valley at 8,000 feet in February and March. In four successive years large numbers appeared over Myitkyina in mid-February during spells of cold weather with heavy rain. Odd birds have been seen in July and August.

It is possible that at least some of these birds belonged to the subspecies *innominata* Hume, believed to breed in China and migrate southwards and westwards in winter, reaching the Andamans (whence the type specimen came) as a straggler; but it is very difficult to distinguish from subspecies *brevirostris* even in the hand (vide Sálim and Ripley, HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, Vol. *4*, p. 28), and there is no definite record from Burma to date.

BLACK-NEST SWIFTLET

Collocalia maxima Hume, Tenasserim (= *lowi*)
Subspecies *maxima* Hume, Tenasserim

IDENTIFICATION A large swiftlet, wing 122-136 mm; tarsus heavily feathered with a distinct row of at least 6 or 7 small feathers on the outer side and a second row of at least 4 small feathers on the inner side; tail more or less square, difference in length between the long outer pair of feathers and the short central pair normally does not exceed 12 per cent of the length of the former, Rump colour variable. Rattle-call proved for several supspecies and probably uttered by all. NEST AND EGGS The nest is of the 'black' type, bracket-shaped, incorporating feathers from all parts of the plumage of the swiftlets, and held together by a firm translucent nest-cement without the inclusion of any vegetable materials. For breeding in the Mergui Archipelago see under next species.

STATUS AND DISTRIBUTION Eastern Himalayas to the Philippines and south to Sumatra, Java and Borneo. Sympatric with *brevirostris* except in Borneo where the latter is absent.

EDIBLE-NEST SWIFTLET

Collocalia fuciphaga (Thunberg), Java
Subspecies: *germani* Oustalet, Pulau Condore
inexpectata Hume, Andaman Is.

LOCAL NAME Burmese: *zi-we-so*

IDENTIFICATION A medium-sized swiftlet, wing 110-125 mm, rump paler than back and tail and marked with dark shaft stripes. In the plumage of the back there are always white tips to at least some of the concealed downy barbs at the bases of the feathers. Rattle-call proved for *germani*.

NESTS AND EGGS The nest is of the 'white' type, constructed almost exclusively of concentric laminae of firm nest-cement; in most nests a few small swiftlet feathers are found adhering to and partially incorporated in the cup. In the Mergui Archipelago the collection of nests

is controlled by the Forest Department under licence. Hopwood (in THE BIRDS OF THE MALAY PENINSULA Vol. IV, pp. 115-116) describes nesting in the Mali Islands off the coast of Tenasserim. The nest measures 2-3 inches across and 1 inch deep, and appears to be made of silvery-white gelatine, though second nests usually contain more feathers than first nests. *C. maxima* (he calls it *C. innominata*) nests in the same caves and is the earlier breeder of the two, plastering its nests at random anywhere above high-water mark from February, a few eggs being laid in the first week of March; whereas *germani* always goes to the top of the cave and does not lay until well on in April. The nest-collectors take the nests of both species. The eggs are 2 in number.

STATUS AND DISTRIBUTION Widespread in S.E. Asia, extending to the Marianas (but not in the Indian Ocean, e.g. Mauritius, where the species is *francica*). It has been obtained on islands off the coast west of Bassein, and is common on the Tenasserim coast and in the Mergui Archipelago; the subspecies *inexpectata* has been obtained once in Tenasserim.

WHITE-BELLIED SWIFTLET

Collocalia esculenta Linnaeus, Amboina
Subspecies: *elachyptera* Oberholser, Bentinck Is.

IDENTIFICATION Characterized by small size (wing not exceeding 107 mm) and by generally blackish upper-parts strongly glossed with blue or green, and much white on the abdomen. None of the subspecies is known to utter the rattle-call.

NESTS AND EGGS Not described from Burma. Normally the self-supporting bracket-shaped nest is of the 'vegetable' type, in which a firm translucent nest-cement is applied in the form of a network of fine threads to bind together the material of the nest cup, and is copious at the hinge. The vegetable materials of which the nest cup is constructed may be very diverse.

STATUS AND DISTRIBUTION From the Mergui Archipelago through Malaysia to New Caledonia.

C/o. WESTMINISTER BANK LTD., B. E. SMYTHIES
40, QUEEN'S ROAD,
CLIFTON, BRISTOL, U.K.,
November 29, 1974.

Note by U Tun Yin, dated 9 May 1974

Launglon Co-operative Society in 1971-72, 350 viss (572040.0 gm), of edible nests were collected by U Tun Yin. All these were taken over by Trade Cor-

poration, No. 2 (Water Products). The nests are classified into four categories, the price fixed for each being as follows:-

No. 1 — Kyats 800.00 per viss.
No. 2 — Kyats 700.00 per viss.
No. 3 — Kyats 550.00 per viss.
No. 4 — Kyats 350.00 per viss.

Nests collected prior to 1971-72 under licence were as follows:-

1966-67 — 526 viss = 859694.4 gm
1967-68 — 338 viss = 552427.2 gm
1968-69 — 328 viss = 536083.2 gm
1969-70 — 289 viss = 472341.6 gm
1970-71 — 432 viss = 706060.8 gm
1 viss = 1634.4 gm
1 kyat = *c.* Rs. 1.35 (Indian currency as on 1974).

9. NOTES ON THE EGG TEETH OF THE HOUSE SWIFT

The egg tooth of birds is an integumentally derived tooth-like protuberance or horny tubercle usually found near the distal end of the upper mandible at the time of hatching. It is generally believed to function "in cutting through shell membranes and shell at hatching" (Clark 1961). A variety of supplementary tooth-like structures have been noted on the lower mandible; a single egg tooth restricted to the lower mandible has been reported for several families of birds.. In some groups of birds the egg tooth is decidedly deciduous and is quickly lost, while in others it gradually disappears without falling off. The presence, distribution and timing of egg teeth in birds have been reviewed by Clark (1961) and Parkes & Clark (1964). Even so, only fragmentary data exist for the order Apodiformes and this is confined to observations of a few swifts of the family Apodidae. We present here more detailed observations of the egg teeth of the House Swift, *Apus affinis.*

Observations were made of an aged series of preserved young as well as of numerous living nestlings of a wide variety of ages examined as part of a study of the post-hatching development of the House Swift. All of the nest sites were in the vicinity of Baroda, Gujarat, India. Newly hatched young House Swifts have what appears to be a typical egg tooth near the distal end of the dorsal surface of the upper mandible. It is whitish in colour and stands out against the mandible which becomes appreciably darker during the first week of post-hatching development. This egg tooth gradually becomes darker and less conspicuous until it finally disappears by the time the nestling is 13 or 14 days old. A second tooth-like structure is present on the lower mandible in the form of a hardened cap to the tip. This protruding structure is noticeably

paler than the adjacent portions of the lower mandible during the first days of nestling life. This cap gradually disappears but was still observable in a 16 day old nestling.

Previously (Parkes & Clark 1964), an egg tooth had been noted on the upper mandible of the Chimney Swift, *Chaetura pelagica,* and Pygmy Swiftlet, *Collocalia troglodytes,* both members of the subfamily Chaeturinae. Egg teeth on both upper and lower mandibles similar to those noted here were recorded by Collins (1968:293) for the Short-tailed Swift, *Chaetura brachyura,* and also for the Chestnutcollared Swift, *Cypseloides rutilus,* a representative of the subfamily Cypseloidinae. The only previous indication of egg teeth in the remaining subfamily Apodinae, of which the House Swift is a member, is the tooth-like rudiments noted in the study of the embryonic development of the Alpine Swift, *Apus melba* (Burckhardt 1954). The rate of disappearance of the egg teeth in *C. brachyura* and *C. rutilus* was similar to that noted here for *Apus affinis* in that they were usually not observable after the age of 14 days (Collins 1968:293). It now seems clear that the presence of a typical appearing egg tooth on the upper mandible and a hardened cap to the tip of the lower mandible is widespread in the Apodidae and probably is typical of all species of the family. These structures are clearly not deciduous and take about two weeks to disappear, at least in the small to medium sized swifts. Observations on some of the larger species in the family might be interesting in this respect. At present no data on the teeth have been presented for the Crested Swifts (Hemiprocnidae) or the Hummingbirds (Trochillidae). Such information on these two remaining families of the order would be interesting, particularly in the light of the recent revival of interest in the degree of relationship of these families (Burton 1971).

This study, part of a wider study of the biology and ecology of the House Swift, has been supported by a Fulbright Research Scholarship (to C.T.C.) and a research grant awarded (to R.M.N.) by the M. S. University of Baroda.

CHARLES T. COLLINS[1]
RAMESH M. NAIK

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October 23, 1974.

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10. ON THE VALIDITY OF *RIPARIA RIPARIA INDICA* TICEHURST AND EXTENSION OF RANGE OF *RIPARIA RIPARIA IJIMAE* (LONNBERG)

In 1916, Ticehurst (*Ibis*: 70) separated Collared Sand Martins *Riparia riparia* (Linnaeus) resident in the Punjab as *indica*, distinguishing them from *diluta* (Sharpe & Wyatt, type locality Tashkent) by their smaller size, shallower fork in tail and less distinct (sometimes absent) band across the breast. In the FAUNA, Stuart Baker accepted this subspecies but under the name *subsoccata* Adams treating *indica* as a synonym. There was some discussion regarding the validity of the name *subsoccata* but subsequent authors have dropped the subspecies considering it as synonymous with *diluta*.

While cataloguing the birds of the Bombay Natural History Society Collection, 11 specimens (16♂♂ 5♀♀:- 1 Attock, 3 Campbellpur, 2 Rawalpindi, 2 Madhopur, Gurdaspur, Punjab; 1 Okhla, Delhi; 2 Manjhaul, Monghyr District, Bihar) could be separated from 8 others (5♂♂ 1♀ 2 o?:- 1 Kashgar, Chinese Turkestan; 2 Chitral, NWFP, 1 Jagadhri, Ambala, 1 Tara Devi 7000′ Patiala, Punjab; 1 Khahi, Pithoro, Sind; 2 Nandur-Madhmeshwar, Nasik, Maharashtra) on the characters mentioned above. The former were collected between 14th December and 9th February and several of the specimens are marked as having enlarged gonads, or even shot off eggs, leaving little doubt that they represent a distinct form resident in Northern India over which area *diluta* was also found as a non-breeding visitor.

Nine more specimens (3♂♂ 2♀♀ 4 o?:- 2 Rham, 14700′, Tibet, 1* Nal, Ahmedabad, Gujarat, 1* *c.* 15 m off Bassein, 1 Mahim, Bombay, 1 Thana District, Maharashtra; 2 Manjhaul, Monghyr District, Bihar, 1 Kaziranga, Assam) are now identified as *ijimae* (Lonnberg) for their darker upperparts and slightly longer tails. The identification of two marked * has been confirmed by Mr. Gorman Bond at Smithsonian Institution.

The 3 subspecies measure:-

	Wing	Bill	Tail
diluta ♂♂ (5)	101-104 (103)	6·1-7·2	43-47 (45·4)
(IH	(99) 102-108	c.6	48-51)
indica ♂♂ (6)	90-95 (92·8)	6·4-7·2 (6·9)	37-40 (38·4)
ijimae ♂♂ (3)	101,105,106	6·7,7·2	46,47,47
(♂♀	99-107	c.5-6	49-5)
diluta ♀ (1)	97	–	45
IH	102-108	c.6	46-5)
indica ♀♀ (5)	92-95	6·2-6·7	37-42 (40·2)
ijimae ♀♀ (2)	102-106	7·1,-	50,53

The occurrence of *diluta* in the Bombay-Deccan and of *ijimae* in Gujarat, around Bombay and in Bihar add to and clarify the known distribution of both subspecies.

75, Abdul Rehman Street,
Bombay 400 003,
March, 7, 1975.

HUMAYUN ABDULALI

11. ON THE VALIDITY OF *LANIUS SCHACH KATHIAWARENSIS* KOELZ

Koelz (1950:7) separated *Lanius schach* from "Rajputana, Kathiawar and possibly also Sind" as *kathiawarensis* (Type locality Junagadh, Kathiawar) as "similar to *L. s. erythronotus* and *L. s. caniceps* but grey on back paler than in either, and rufous on the back less extensive than in *L. s. erythronotus* but generally more than in *L. s. caniceps*". Biswas (1950:449) accepted it from Sind, Rajputana, and Kathiawar, and repeated the description.

Subsequently, Sálim Ali (1954:781) and Ripley (1961:262) included it with *caniceps*, as has been done again in Ali & Ripley (1972:96).

As *caniceps* merges into *erythronotus* and the migrations of the latter regularly lead to both races being together in the same area, some individuals are difficult to identify with certainty. Together with this, the description of *kathiawarensis* is perhaps not very convincing; but an actual comparison of six specimens in the collection of the Bombay Natural History Society [4 Kutch, 1 Bombay, and 1 Simla (?)] with other specimens of the species in the collection (58 *erythronotus*, 15 *caniceps*) shows a striking difference. In addition to the grey on the back, the rufous on the rump is paler and more restricted than in both these subspecies. On this material and for the reasons given, I would confirm the validity of *kathiawarensis*.

Of the 4 specimens from Kutch (2♂♂ 2♀♀), three were shot off nests in August; the fourth was obtained on 21st March. The breeding

birds are marked *caniceps* and the last *erythronotus* by Sálim Ali with the note that the identifications are by Meinetzhagen, which opinion he (Sálim Ali) confirms in the text (1954:782).

Specimen No. 4691 is marked "Simla, July 1886, Capt. Anderson". In the first list of members of the Society published in Vol. 1 of the Society's Journal (January 1886), there are several persons of this name including a Capt. W. R. Anderson from Simla. Later on p. 12 in "Catalogue of Birds as yet in the Collection of the BHNS" is listed one specimen of *Lanius erythronotus* donated by Col. W. B. Thomson from Kashmir. In the July number of the same volume is another list of birds presented by A. T. H. Newnham but whose origin is not mentioned. Newnham contributed several notes from Kutch. The list includes a specimen of this species, as also other species likely to be found in that area. Subsequent numbers of the *Journal* were examined but though specimens sent in by members are mentioned in some detail, no reference to this species from Simla and/or from Capt. Anderson is traceable. In view of the improbability of the distinct subspecies restricted to Kutch and its immediate neighbourhood, being found so far away as Simla, I would suggest that there has been some mix-up among the labels and this specimen may originally have been from Kutch too.

The Bombay bird, obtained by A. Brosset near Thana on 6th February, 1964, is the only evidence of this race being migratory, unlike *caniceps* which is sedentary and whose movements, if any, are very restricted.

75 ABDUL REHMAN STREET, HUMAYUN ABDULALI
BOMBAY 400 003,
October 21, 1974.

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12. FURTHER NOTE ON THE PAIR FORMATION OF THE COMMON MYNA, *ACRIDOTHERES TRISTIS*

The existence of life long pair bond among birds is still shrouded in mystery. Although a number of bird species have been said to pair for life there is little concrete evidence (Van Tyne & Berger 1959). However, Lack (1940) cited a number of example of bird species which were suspected to pair for life. In the present paper I would like to record the preliminary findings on the multi-year pair bond among the Common Myna as observed at Santiniketan, W. Bengal, India from 1969-1973. The presentation of this paper was felt necessary since it gave some new information on the duration of the pair bond in birds as envisaged in the Common Myna and since there was little reliable data on the subject.

In a previous paper (Sengupta 1968) I mentioned that pair formation among the Common Myna 'takes place in the early spring and dissolves after the young have been raised', i.e. for a period of 4-5 months. Incidentally, its breeding period ranged from April to June and parental bond with the young ended around the middle of August.

However, my conclusion on the pair bond was then based largely on observations and by ringing four nesting pairs at Sinthee and Berhampore, W. Bengal. In April 1970, ten nesting pairs were colour ringed (Pair No. 1-10). They were found in pairs even after the dissociation of the parental bond around the last week of August. They were not defending a territory after the young had left and explored food as and where available. Their bond continued through winter when they roosted as usual on the communal roosting site among the foliage of trees situated at the southern outskirt of the University campus. In April 1971 all the ringed pairs (1-10) established breeding territories and nested with the old partners and successfully raised young. Being stimulated by this result in June 1971 another 20 nesting pairs (P. No. 11-30) were ringed. Regular observations were made to spot the different ringed pairs and their behaviour noted. This showed the repetition of the last year's observation. During late April 1972 when territory was established by Pair No. 1—30 of 1970-71, it was noted that partner of Pair No. 2 was nesting with an unringed bird. But it was not known whether the change of mate was necessitated by the desertion of the partner or by its death. However, in May 1972 another 24 nesting pairs (P. No. 31-54) were ringed. From 1972 onward regular observation was restricted to four pairs (P. No. 4, 7, 12, 18) which fed mostly around my residence to note the daily association of the individual pairs. May 1973 saw the nesting of the ringed birds with their old partners except Pair No. 16 and 20. These two pairs could not be located. Another 10 pairs (P. No. 55-64) were ringed in June 1973. In February

1974 I made a thorough survey to locate all the ringed Myna at different regions of Santiniketan in seven different days spending a total of 6 hours (Average) daily. This resulted in observation of the individual ringed pairs feeding, roosting and performing other function together during most of the time. During the nesting season of 1973 Pair No. 2, 8, 35 & 40 acquired old territories and others established new territories as usual. The return to the old territory was presumably a chance affair.

Careful observation on the un-ringed Myna population also clearly showed the continuance of the pair bond beyond the breeding season. As one could find the Common Myna feeding, moving, returning to the roost in two throughout the year.

It was also interesting to mention that Pair No. 8 continued occupying and defending its breeding territory through the winter of 1973 and was doing the same till the writing of this note. This pair fed mostly in and around its territory. But none of the other ringed Mynas occupied territory beyond the breeding season though they maintained the pair bond throughout the year.

Therefore it could be concluded from the present investigation that the pair bond in the Common Myna extends for several years (may be for life) and there is possibility of other birds of this family doing the same.

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October 9, 1974.

S. SENGUPTA

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13. OCCURRENCE OF BANK MYNA *ACRIDOTHERES GINGINIANUS* (LATHAM) IN VISAKHAPATNAM (A.P.)

A small group of Bank mynas were seen feeding among the *Tephrosia* undergrowth near Lawsons bay colony in Visakhapatnam on 20th February, 1974.

Again on 29th August, 1974, I saw them more or less in the same area and Mr. K. S. R. Krishna Raju confirmed their identity.

The SYNOPSIS (1961) mentions that it wanders as far south as Madras and the HANDBOOK (*5*:181) records a report of a lone specimen from Madras, adding that the bird might perhaps be a cage bird. In the absence of any published date on its occurrence in Andhra this record adds Northern Andhra to its known range of distribution.

C/o PRINCIPAL,
SRI L. BULLAYYA COLLEGE,
A. U. CAMPUS,
VISAKHAPATNAM 3 (A.P.),
September 6, 1974.

K. J. N. G. SANKAR

14. CURIOUS BEHAVIOUR OF A LOTEN'S SUNBIRD (*NECTARINIA LOTENIA*)

Early in the morning on 26 February, 1974, two or more nestlings of the Tailor Bird (*Orthotomus sutorius*) had left their nest in a small plant at the foot of a wall in the large open plot just north of our house in Trivandrum, Kerala State.

At 1115 hours, my wife, who combines her bird watching with her outdoor household jobs, noted a family of Tailor Birds on a small tamarind tree in our backyard and summoned me. There was one juvenile only and the parents were hopping about around it in some excitement and uttering an incessant *chit-chit-chit-tit-tit-tit* note.

Just then a male Loten's Sunbird in eclipse plumage came and began probing the juvenile Tailor Bird's vent with its long bill. The chick responded by begging for food. The sunbird not only pecked at and prodded the cloaca of the Tailor chick, but quite frequently pulled the latter's almost invisible stub-tail. At times the sunbird took hold of the chick's short primaries one at a time and tugged so hard that the chick had a hard time of retaining its hold on the perch. Strangely enough, the parents who were close by made no move to drive the sunbird away. Only when the sunbird withdrew some distance from the chick would one or the other parent Tailor fly at the sunbird.

The parents appeared to be trying to lead the chick to a more sheltered place. Our presence could also have had something to do with the reluctance of the parent birds to go too near their chick.

The harassed juvenile tried to escape the attentions of the sunbird by fluttering from one twig to another, out the sunbird was most persistent and as soon as the chick had settled down on a perch started probing, prodding and pecking again!

The Tailor Bird family sought refuge in a thickly foliaged *Cassia fistula* which was a few yards away from the tamarind tree. Still the sunbird followed and began its antics again. Just then we noted an adult

Tailor Bird coaxing a second juvenile along our roof of the *Cassia.* Here the sunbird was still busy with juvenile No. 1 which had by then begun alternately to beg for food from and make sudden lunges at its tormentor. The sunbird occasionally sat above juvenile No. 1 and hung head down to poke the vent of the poor chick as though it were seeking nectar from a pendent flower.

Meanwhile a parent had fed juvenile No. 2 a few times. The sunbird now transferred its attentions to juvenile No. 2 which, however, was much more agile than No. 1 and kept jumping from twig to twig. The parents had meanwhile fed juvenile No. 1. The sunbird suddenly left juvenile No. 2 and returned to No. 1. The chick flew to a mango tree close by, with the sunbird in pursuit. One of the parents made a feeble and futile attempt to drive away the sunbird.

Unfortunately, neither my wife nor I could continue watching beyond 1150 hrs., but we noted that soon after we had gone in the *chit-chit-chit-tit-tit* notes of the parents ceased.

What could the sunbird have been after? Did it mistake the pink and red vent of the juvenile Tailor Bird for a flower and probe it, discovering in the process that some fluid exuded from it? Was that the reason for its persistent pursuit of the chick? Does any fluid ooze from the chick's vent? If so, does it increase in quantity soon after the chick is fed?

It will be interesting to know others have observed such behaviour on the part of a sunbird or any other bird.

UNIVERSITY COLLEGE, K. K. NEELAKANTAN
TRIVANDRUM,
May 29, 1974.

15. WESTERNMOST RECORD OF THE SCARLET FINCH *HAEMATOSPIZA SIPAHI*

Reading through the tenth Volume of the HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN I find that the range of the Scarlet Finch *Haematospiza siphahi* has been given as "The Himalayas from Central Nepal.... east through Darjeeling.........". In the summer of 1957 our family had gone on a pilgrimage to Kedarnath and Badrinath in May. I had been walking ahead of our party and on the final climb up the valley to the shrine of Kedarnath, I scanned a cliff at a sharp turn in the track and my gaze was arrested by a brilliant scarlet bird perched in the morning sunlight on a sprig. Nearby was the dull less attractive female. I was in admirable position to take in all the characteristics and watched the birds for about twenty minutes. Having seen the bird illustrated in Gould's monumental work, THE BIRDS OF ASIA and having taken a close

up colour photograph of the illustration, I immediately recognised the living birds in my view.

Shivrajkumar who followed a little later immediately noticed the bird which flew away. The altitude we saw the pair in May was about 8,000′. The forests on the mountains above were mainly oak admixed with Rhododendron. I am certain that the bird occurs vary much to the west in suitable habitats.

It is quite apparent that in a large country like ours, the exact ranges of birds will be extended as more and more people take to observing birds send in their information to the Society. Equally true is the fact that many more species must be becoming rare or totally exterminated as the habitat is being damaged by exploitation by Man.

C/o. World Wildlife Fund-India, Hornbill House, Opp. Lion Gate, Shahid Bhagat Singh Road, Bombay 400 023,
January 7, 1975.

LAVKUMAR J. KHACHER

16. OBSERVATIONS ON A YOUNG CHEQUERED KEELBACK SNAKE (*XENOCHROPHIS PISCATOR*)

The snake was captured in a stream near Poona on 30-vi-1974. The best efforts at measuring its length put this at about ten inches. When it was released into another stream on 6-x-1974, the length was estimated at fourteen inches. The body remained very slender throughout the period of captivity. During these 98 days the snake was kept in a circular glass fish-bowl $9\frac{1}{2}$ inches in diameter and the same in depth. Three small tiles were piled up in the centre of the bowl in such a way as to leave a hiding-place beneath the lowest tile, and sufficient space all round for swimming. Water was added until the surface of the topmost tile was just clear. It was soon found necessary to cover the mouth of the bowl with wire gauze in order to prevent escape. Small "minnows" ranging in length from about $\frac{1}{2}$ inch to 2 inches were introduced into the bowl from time to time. These were taken, sometimes at once, sometimes after a few days, and sometimes even when dead. Feeding took place both by day and by night. Very small fishes were usually ignored, even when the snake must have been hungry. The preferred length was observed to be from 1 to $1\frac{1}{4}$ inches. Average daily consumption seemed to be about four fishes.

Usually the selected fish would be closely but cautiously approached and then seized by a sudden dart. Seizure would be by the head, middle or tail. Fish were swallowed most easily from a head seizure, but could also be swallowed, after a struggle, from the tail. Once a fish

that was presumably found too lively was lifted and swallowed out of the water; otherwise, all were devoured under water.

So long as the snake remained motionless (as it often did with its head and fore-part perpendicular in the manner of a stalk of water-grass) the fishes showed not the least fear of their predator, and would approach quite close. This lack of fear was equally shown when the snake gently undulated its upper part like a swaying weed.

Skins were sloughed on about 17 July, 7 August, 10 September and 6 October. Dates must be approximate, since the sloughed skins were so inconspicuous in the water that they may not have been noticed until a day or so after being cast.

The snake settled down in captivity quite readily. At first it spent nearly all the time hiding under the lowest tile, only coming out to breathe or feed. It was at first easily scared by any movements outside the bowl, but after a few days it grew used to these.

In the early morning it was often found resting on the top tile out of water. At night it often climbed up to the mouth of the bowl, where it would lie, well concealed, around the inner rim; hence the necessity of keeping the bowl covered with wire gauze. Once, when the cover was accidentally left off for some time, the snake escaped from the bowl and was found lying on the shelf at a distance of one foot or so. When I seized it by the middle, it made as if to bite, but did not actually do so; instead, it sprayed some foul-smelling liquid—presumably, excreta—over my hand before I could replace it in the bowl.

When coming up for air, the snake would thrust its head clear of the water and "drink" the air by working the muscles of its throat. On 17 July, a little before the first sloughed skin was detected, it pushed its head above water and yawned several times.

The snake was released because I could no longer spare the time to catch a constant supply of minnows. Eventually, of course, it would have grown too large for the bowl. For anyone with the time and resources to maintain a food supply, a juvenile Water-snake can be recommended as an unusual and interesting pet.

It is non-poisonous and—in my own experience—non-aggressive.

THOMAS GAY

DEV KUNJ,
PRABHAT ROAD,
POONA 411 004,
January 10, 1975.

17. A SNAKE-TOAD INCIDENT

Humayun Abdulali's note [*J. Bombay nat. Hist. Soc.* *68*(2):463] reminds us that during the rainy season of 1966, a male Green Keelback (*Macropisthodon plumbicolor* Cantor) was found struggling inside the campus of the Veterinary Dispensary at Chandaka, Puri District, Orissa. The animal was secured and found to be about 51 cm long and had the left forelimb of a Common Toad (*Bufo melanostictus*) piercing the right abdominal wall at the 66th ventral scale.

It would appear that such accidents occasionally happen and we may also, refer to an interesting note on 'The Biological Control of Dung' in the *Scientific American* for April 1974, p. 179, where D. F. Waterhouse mentions a Dung Beetle (*Onthophagus cunniculatus*) which broke through the body of a small Australian toad which had swallowed it!

ZOOLOGICAL SURVEY OF INDIA, S. BISWAS
CALCUTTA 700 013.

NANDANKANAN BIOLOGICAL PARK, L. N. ACHARJYO
P.O. BARANG, DIST. CUTTACK,
ORISSA,
September 12, 1974.

18. MARSH CROCODILE *CROCODYLUS PALUSTRIS* IN THE GIR

(*With a photograph*)

The Indian marsh crocodile (*Crocodylus palustris*) has been wiped out in most of its former range. It survives now in only the most remote and protected areas. The following information was obtained through a three day survey of the crocodile population in Kamleshwar Lake inside the Gir Sanctuary, Gujarat, in June, 1974.

Night counts were made on 13-vi-1974 and 16-vi-1974 by slowly walking around the banks of the lake and shining a powerful torch from eye level to catch the eye reflection of crocodiles. On 13-vi-1974 a total of 27 crocodiles were observed from midnight to 4 a.m., 15 on the banks and 12 in the water. On 14-vi-1974 observations made during daylight from the top Kamaleshwar Dam showed seven crocodiles. On the night of 16-vi-1974 a total of 29 crocodiles were spotted between 6 p.m. and midnight, 14 were on land ('night basking') and 15 were in the water.

Some crocodiles were approached within 3 metres but most fled when 12 to 15 metres away. There has been no previous census or studies undertaken on the crocodiles in this lake but it appears to be an

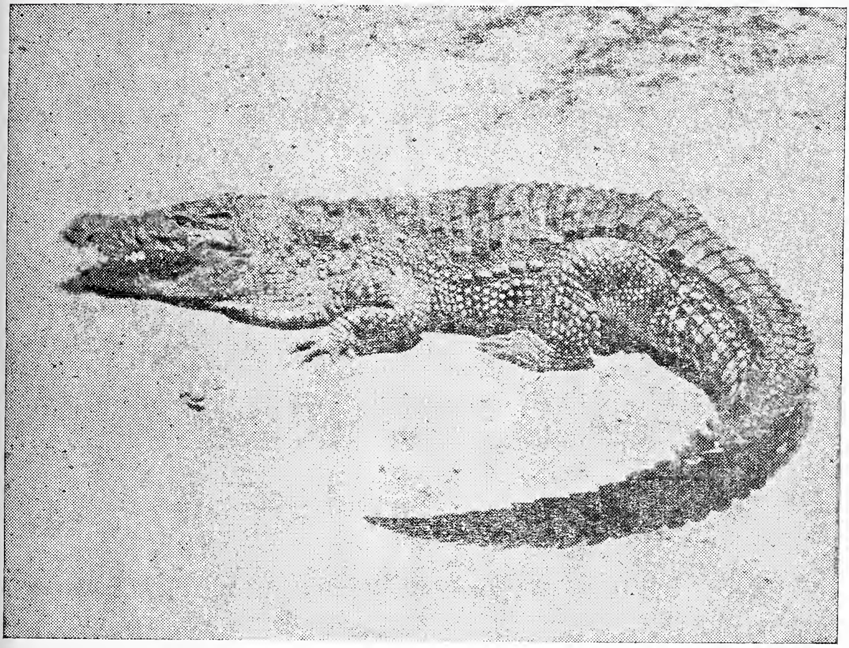

Photo. *Crocodylus palustris* (adult male).

important population that deserves more attention and management as a natural gene pool for this rapidly dwindling reptile.

INDIAN YOUTH ASSOCIATION FOR CONSERVATION.

MADRAS SNAKE PARK TRUST,
MADRAS 600 022,
December 3, 1974.

ANN JOSEPH
EKLAVYA CHAUHAN
KUSHAL KHANNA
R. WHITAKER

19. FURTHER ADDITIONS TO THE FISH FAUNA OF THE CHILKA LAKE

A list of the fish fauna of the Chilka lake numbering 118 given by Hora (1923). Jones & Sujansinghani (1954) considered only 112 as valid species out of the 118 species listed by Hora as six were synonyms of recorded species. Koumans (1941) added one Gobiid fish from the lake, thus bringing the number to 113. Jones & Sujansinghani (op. cit.) presented 25 new records, raising the total number of species recorded from the lake to 138. Later Roy & Sahoo (1957) added 14 more species, bringing the total to 152.

We recorded the following eight additional species from the Chilka lake while operating gill nets in the outer channel, inspecting catches

from mass fishing ('Kotha Bahani') near the lake mouth and studying fish landing composition in the Chilka lake during 1972-73.

The fish collection reported in this note was made during May-November, 1972 and December, 1972-January, 1973. The first three species are fresh-water in origin and others marine forms.

Family CLARIIDAE
Clarias batrachus (Linn.)

This mud dwelling fish was found in catches from Bhusandapur-Kaluparaghat area and along Balugan shore during the months of May to July, and was caught in appreciable quantities from the shallow mud flats of the lake near Kaluparaghat during June, 1972. Size range of 146 to 245 mm. Local name: *Magura.*

Family CYPRINIDAE
Labio calbasu (Ham.)

Three of the Indian major carps (*Labio rohita, Catla catla* and *Cirrhina mrigala*) were earlier recorded from the Chilka lake (Jones & Sujansinghani, op. cit.; Roy & Sahoo, op. cit.). This major carp (*Kala-bainshi*) was found in the catches from the northern sector of the lake in the vicinity of the river Daya during the months of June to September. It is probably brought in by the monsoon floods. The species is capable of tolerating certain degree of salinity. The largest specimen observed at Kaluparaghat was 287 mm.

Family NOTOPTERIDAE
Notopterus chitala (Ham.)

Stray catches of this species were observed during the monsoon months near Kaluparaghat and in the vicinity of the river Daya in the northern sector of the lake. A few specimens observed in the fish landings at Kaluparaghat during August, 1972 were in the size range 110-157 mm. These juveniles were perhaps brought into the lake by the flooded rivers. Local name: *Chitala.*

Family CARANGIDAE
Caranx gallus (Linn.)

This fish was observed in the mass fishing ('*Kotha bahani*') catches of the 'Nolia' fishermen in outer channel near the lake mouth during the winter months. This marine species is probably a stray visitor from the sea and its distribution in the outer channel extended up to Mirja-pur according to the fishermen. It is sold in the miscellaneous group of

fishes. The average size of 4 specimens collected was 127 mm. Local name: *Jhanjara.*

Caranx leptolepis (Cuv. & Val.)

A number of specimens of this species were collected from mass fishing catches from the outer channel near Kalabanta. It does not form a fishery in the lake and is sold under miscellaneous group of fishes. The average size of the collected specimens was 153 mm. Local name: *Kanti.*

Caranx gymnostethoides (Blkr.)

Three specimens of this species were collected from the mass fishing by 'Nolia' fishermen near the lake mouth in the outer channel during January, 1973. Its catch was insignificant and rare. Local name: *Kanti.*

Family LEIOGNATHIDAE

Equula splendens (Russell)

This marine species was found in *Khadijal* catches near Arakhakuda in the outer channel but its catch was insignificant. The specimen was also collected from the *Khadijal* catch near Keshpur which was a rare occurrence along the western shore of the lake. The specimens observed in the outer channel ranged in size from 63 to 84 mm. Local name: *Karachandi*

Family URANOSCOPIDAE

Ichthyscopus inerme (Swainson)

Five specimens of this species were caught in the gill net in the outer channel near the lake mouth and at Arkhakuda during January, 1973. It is a marine species and rare in the lake catches. As reported by the local fishermen, the species is not found in the upper reaches of the outer channel where salinity is comparatively low. The collected specimens were in the size range 182-288 mm. Local name: *Balighumara.*

ACKNOWLEDGEMENTS

We are grateful to Dr. P. M. Misra, Director of Fisheries, Orissa for his kind permission to publish this note and to Shri K. C. Pati, Assistant Director of Fisheries for his help in this study.

CHILKA BIOLOGICAL STATION, S. K. MOHANTY
BALUGAON,
ORISSA,
October 30, 1973.

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20. NEW RECORDS OF PRAWNS FROM LAKE PULICAT WITH NOTES ON THEIR DISTRIBUTION

Lake Pulicat is a marine fauna dominated brackish water system on the east coast of India. It is one of the chief sources of fish supply to Madras City (Moses 1923). A preliminary survey of the flora, fauna and fisheries of the Lake Pulicat was made by Chacko *et al.* during the years 1951-52. This note deals with additional records of prawns from Lake Pulicat.

Altogether 23 species were recorded during the years 1966-68 are listed.

Family PENAEIDAE

1. *Penaeus indicus* M. Edw.
2. *P. monodon* Fabricius
3. *P. semisulcatus* de Haan
4. *P. japonicus* Bate
5. *P. merguiensis* de Man
6. *Metapenaeus monoceros* (Fabricius)
7. *M. dobsoni* (Miers)
8. *M. brevicornis* (M. Edw.)
9. *M. affinis* (M. Edw.)
10. *M. burkenroadi* Kubo
11. *Metapenaeopsis stridulans* (Alcock)
12. *Parapenaeopsis nana* (Alcock)
13. *P. cornuta maxillipedo* Alcock

Family SERGESTIDAE

14. *Acetes erythraeus* Nobili

Family PALAEMONIDAE

15. *Macrobrachium rude* (Heller)
16. *M. scabriculum* (Heller)
17. *M. malcolmsoni* (M. Edw.)
18. *M. lamarrei* (M. Edw.)
19. *Periclimenes indicus* Kemp

Family ALPHEIDAE

20. *Alpheus malabaricus* Fabricius
21. *A. paludicola* Kemp
22. *Ogyrides striaticauda* Kemp

Family CRANGONIDAE

23. *Pontophilus hendersoni* Kemp

Seven (1 to 3, 6, 7, 14, 21) of the 23 prawns and shrimps listed above have been recorded by previous workers (Chacko *et al.* op. cit.). The majority of the forms are marine in origin. The freshwater component of the fauna is very poor (15 to 18). The dominance of marine forms is presumably the result of its proximity to the Bay of Bengal, absence of large rivers draining into the Lake, dry weather conditions prevailing for about 8-9 months in a year and low rainfall.

It is of interest to note that the prawn, *Parapenaeopsis cornuta maxillipedo* entered the lake only during the period April to August. *Metapenaeus burkenroadi* is a new record for Cochin backwater (M. J. George 1964) but in the Lake Pulicat it occurs throughout the year forming a minor commercial fishery.

Several immature specimens of *Penaeus semisulcatus* showed both developing petasma and thelycum, a character in hermaphrodites, as observed in Lake Chilka (Subrahmanyam 1966). Two specimens measuring 117 mm and 88 mm showed fully developed petasmal folds (not yet fused) and thelycum. The cause of the prevalence of hermaphroditic individuals only in *P. semisulcatus* is not clearly understood.

The bulk of the commercial prawn catch is composed of seven species: *Penaeus monodon, P. indicus, P. semisulcatus, Metapenaeus monoceros, M. dobsoni, M. affinis* and *M. burkenroadi,* of which *Penaeus indicus* is the predominant species, contributing on the average 300 tonnes (60% of the total prawn catch). Detailed investigations on the biology of these forms have been made and will be published elsewhere.

ACKNOWLEDGEMENTS

I am very grateful to Dr. V. J. Jhingran, Director, Central Inland Fisheries Research Institute, Barrackpore, for encouragement.

CENTRAL INLAND FISHERIES RESEARCH INSTITUTE,
BARRACKPORE,
January 4, 1974.

M. SUBRAHMANYAM[1]

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21. BEHAVIOUR DURING ECDYSIS AND THE MODE OF ECLOSION FROM EGG IN *LOBELLA* (*PROPEANURA*) *CORALLINA* (IMMS, 1912) (COLLEMBOLA: NEANURIDAE)

There is no information avaliable in literature on the moulting behaviour and the mode of eclosion from eggs for any species of *Lobella*. What little is known mostly concerns other genera of Neanuridae.

Material and Method

The species is common in and around Dehra Dun, Uttar Pradesh and the examples studied from various localities agree with the original description and the redescription given by Yosii (1966), in all details, except in the median tooth of the mandible which is little exaggerated than what was depicted by Yosii (loc. cit.) from Ceylonese examples.

In the second week of July, 1965, an attempt was made to set up a culture with five specimens (1 ♀ and 4 ♂ ♂) in a pair of petridish with some semi-humified leaf-litter, brought from the locality where the specimens were collected (Sahasradhara Hills, Yamuna Forest Division, Dehra Dun, U.P.). Moist filter papers were placed on the floor of the rearing petridish and on the inner surface of the cover to maintain requisite moisture in the culture. Pieces of bread, soaked in water, were used as food for the species.

Biology

The species in nature is found underneath decaying leaf-litter, saturated with moisture. It is bright coral-red in colour and is usually sluggish in habit and when disturbed shows a tendency to go deeper into the litter. Females are conspicuously larger than the males and in any

population the males outnumber the females. They are mostly saprophagous and thrive on the juices of humid litter. When any portion of the body is touched, the insect reacts by falling on its side and twisting its abdomen and regains its normal posture the next moment.

Pre- and Post-moulting behaviour

Collembolans undergo ecdysis often in their life. Just on the eve of ecdysis, the individual becomes passive and rarely moves even when disturbed. It usually rests on the ground supporting itself on its antennae with the head depressed on the ground and the body parallel to the ground. The colour fades. After about 6-7 hours, a movement of alternate contraction and relaxation both antero-posteriorly and dorso-ventrally starts at the thorax and a wave of contraction and relaxation, elevation and depression engulfs the entire body in quick succession. At last the skin ruptures at the right side near the junction of head and thorax and the insect emerges out of the skin by first extricating its head and thorax from the ruptured cuticle. Later on, it frees its legs from the skin and with the help of antennae and legs the whole insect comes out.

Post-moulting behaviour of the insect varies and can be summarised as follows: In general, all individuals after moulting contract, relax and sometimes curl the body and sometimes lie on their back with the legs showing no movement. The insects, start normal locomotion after 15 minutes. Just after ecdysis, they look pale and regain the deep coral-red colour after 2-3 minutes. The species moults at an interval of 6-7 days.

Oviposition and mode of eclosion

The female, in the culture, laid two batches of eggs on the fifth day after the establishment of the culture. The larger batch consisted of 34 eggs and the smaller one 7 eggs, some of the eggs of this batch were distinctly smaller than others. The majority of the eggs were oval in shape and brownish-white in colour and measured from 0.12 to 0.25 mm on their widest aspect. The surface of the eggs was smooth and glistening and no processes could be seen even under high magnification. The eggs gradually became dark brown in colour as the embryo developed. On the fifth day of oviposition, eclosion of 1st instar nymphs took place from all the seven eggs of the smaller batch. On the same day, movement of the nymphs inside the eggs of the larger batch was seen through the thin chorion of the eggs. The eggs from which eclosion was imminent could be marked by their deep brown coloration. Eclosion from

the larger batch started also on the fifth day of oviposition and continued upto ninth day.

Mode of eclosion: The region of egg from where the eclosion of the nymph would take place depends on the position of the egg in that batch. Eclosion usually took place from the exposed surface and never from the suarface which remained overlapped by other eggs. During eclosion, a slit approached at one of the poles (free pole in case of an overlapped egg) apparently owing to vigorous movement of the nymph inside. As the slit widened gradually, the nymph made its appearance first by protruding the tip of its abdomen outside. With the support of its legs on the inner floor of the egg the nymph pushed itself out more and more. As soon as the hind legs came out, it took their support of the adjacent eggs to extricated itself completely. Newly emerged nymphs were very active and fed vigorously.

Appearance of first instar nymph: Newly hatched nymphs were white in colour with reddish suffusion and changed to pale brown within half an hour after their emergence. The ocellar fields were seen to be the darkest with granular reddish pigment but the ocelli were not very prominent. Although the lateral bosses were perceptible, no trace of dorsolateral bosses could be noticed. The nymphs measured *c.* 0.05 mm in length with the labium protruded anteriorly. On the seventh day of the eclosion, rudiments of bosses were visible on the dorsolateral surface of body and the ocelli became conspicuous in the form of elevated domes.

ACKNOWLEDGEMENTS

I am grateful to the Director, Zoological Survey of India and to the Officer-in-Charge, Northern Regional Station, Dehra Dun, for providing necessary facilities.

ZOOLOGICAL SURVEY OF INDIA, S. K. MITRA
34, CHITTARANJAN AVENUE,
CALCUTTA 700 012,
July 21, 1973.

22. BUTTERFLIES OF NEW DELHI (PAPILIONOIDEA)

I would like to make a few comments on Roger Ashton's paper under the above title (1972, *J. Bombay nat. Hist. Soc.* *69*:502-509).

Danaus chrysippus (L.)—It is a great pity that advantage was not taken of the capture of a female f. *dorippus* Klug to try to work out the genetics of this form. On the Kenya Coast, where *dorippus* is the prevalent form, it is dominant to *chrysippus*, and it would have been

interesting to see whether this is also the case in Delhi, where it is rare, or whether there are two different genes producing a similar phenotype. The species is not difficult to breed; a female confined in a large glass jar and supplied with a leaf or two of the food-plant [*Calotropis* spp. (Asclepiadaceae)] will lay freely if the jar is illuminated by a 60 watt bulb placed close to. The larvae can suffer severely from a Tachinid parasite, that lays its eggs in the tomentum on the underside of the *Calotropis* leaves, and it is essential to remove the tomentum from the leaves supplied for food.

Chilasa clytia (L.)—I do not think that it is correct to describe the large *dissimilis* L. form as a mimic of *D. limniace* (Cr.) and the small examples as mimics of *D. aglea* (Cr.). Mere size is of little or no importance in cases of mimicry, and it is far better to look on *dissimilis* as a mimic of a generalised blue and black *Danaus*.

Hypolimnas misippus (L.)—It seems strange that ff. *inaria* Cr. and *alcippoides* Btlr. should occur in view of the almost complete absence of their Danaid models.

Atella phalantha (Drury)—I do not think that *Barleria prionitis* (Acanthadaceae) can properly be recorded as a food-plant only on the strength of a female laying on it, unless larvae were also reared to maturity. The normal food-plants of *Atella* belong to the Flacourtiaceae, Celastraceae and Salicaceae.

I have recently watched a female of *Papilio demodocus* Esp. fly round and round an orange tree (Rutaceae), the food-plant, and then lay an egg on a small plant of *Euphorbia hirta* (Euphorbiaceae) growing at its base, an examination revealed a second and earlier laid egg on the same plant. Also, many years ago in Calcutta, I found eggs of *Danaus chrysippus* (L.) on a cultivated *Hibiscus* sp. (Malvaceae), on grasses (Gramineae) and on a strand of steel fencing wire, that were all mixed up in a plant of *Calotropis procera* (Asclepiadaceae), the proper food-plant.

P.O. Box 95026, D. G. SEVASTOPULO
MOMBASA,
KENYA,
September 5, 1973.

23. HAIRY CATERPILLARS ON BANANA IN MYSORE STATE

During July and August, 1972 the caterpillars of *Argina syringa* Cram., *Diacrisia obliqua* Walker and *Euproctis fraterna* Moore were observed feeding on banana in Hebbal and during the same period these insects were found feeding on the same host at Nanjanagud, Channapatna and Mandya. The young caterpillars fed gregariously on the under-surface

of banana leaves leaving only the upper epidermis. As a result of this the leaves skeletonised, dried and curled downward. In severe cases, the leaves completely dried. The grown up caterpillars defoliated the plants, especially of the tender leaves, and migrated from plant to plant.

In recent years, outbreaks of *D. obliqua* and *E. fraterna* have been noted on *Dolichos lablab*, limabeans, mulberry, horsegram, soybean, blackgram and *Phaseolus mungo* causing considerable loss round about Bangalore.

This report is the first on banana.

ACKNOWLEDGEMENTS

We wish to express our indebtedness to Dr. G. P. Channa Basavanna, Professor of Entomology, College of Agriculture, Bangalore for going through the manuscript and making necessary corrections.

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July 17, 1973.

B. N. VISWANATH
B. L. VISWESWARA GOWDA

24. OCCURRENCE OF GREEN STRIPED BORER, *MALIARPHA SEPARATELLA* RAGONOT ON SORGHUM IN THE PUNJAB

Maliarpha separatella Ragonot (Phycitinae, Pyralidae: Lepidoptera) has been reported as a common pest of rice in Africa (Anonymous 1970) and is widely distributed in Ethiopean, Palaeotropic and Oriental regions (Kapur 1967). In India *M. separatella* was reported by Hampson (1896) as *Anerastia pallidicosta* from Punjab and Arunachal Pradesh. He also gave its distribution as Sri Lanka, Burma and China. After this record this insect does not seem to have been reported from anywhere in India.

During December 1971, green caterpillars were observed in the stubbles of sorghum 2-4 cm below soil level. On an average one larva per stubble and as many as 12 per cent stubbles having more than one larva with a maximum of 4 larvae only in 5 stubbles were recorded. During September 1972 larvae were observed in the basal region of sorghum plants (CSH-1). The larvae were again observed during November-December 1972 in the stubbles. This is the first record of sorghum as a host of *M. separatella*. So far it has been recorded primarily from rice plant in Africa and rarely from a wild grass weed *Echinochloa holubii* in Swaziland (Anonymous 1970).

Preliminary observations on its biology was made in the laboratory by supplying fresh tender splitted stems of sorghum to the larvae and changing the food as and when required. Brief description of various

stages is given below. Larvae; well developed body light green, head light brown, exhibit sexual dimorphism. Male larvae with five violet to reddish stripes measured 20-25 mm. Female larvae 30 mm in length, stripes poorly defined. Crochets are complete and biordinate. Larval period lasted for about 6-9 weeks, during winter. A thin silken cocoon was spun for pupation. Pupae; greenish when freshly formed turned brownish with age. Six anal conspicuous setae were borne by both sexes of pupae: Pupation occurred in the basal stem region or in stubbles and lasted for 14-16 days. Maximum pupation took place at the end of February and moth emergence continued up to middle of March. Adults are stout (20-25 mm) with prominent dark red coloured band on forewings, more deep in females. The female laid yellowish white oval eggs in batches of 5-16 on the wire mesh of cage.

Since rice is attaining importance in the Punjab and the area is on the increase, it is quite likely that *M. separatella* might shift to rice to attain the status of a major pest of that crop in India like in Africa or may prove serious on sorghum. More information is needed on its biology and seasonal abundance on sorghum.

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25. A NOTE ON THE BEHAVIOUR OF THE DAMMER BEE, *MELIPONA IRIDIPENNIS* D.

The tiny, dark, dammer bee, *Melipona iridipennis* D. (Apidae: Hymenoptera) inhabits crevices in walls, hollow trunks of trees etc. The sting

is not well developed and the combs are made of a mixture of earth or resin and wax. Its honey is supposed to have high medicinal properties even though the honey gathered is only small in quantity.

During July 1973 an interesting behaviour was exhibited by members of this species. Metal labels painted yellow ("Spartan", "Chemolac" and "Kangaroo"—Synthetic enamel—lemon yellow paints) and erected in partly dried condition in the sorghum field in Tamil Nadu Agricultural University, Coimbatore were noticed having clusters of the dammer bees, all actively scraping and collecting the paint. The pollen baskets in each bee were laden with masses of yellow paints scraped from the labels. The scraped areas showed characteristic dull depression and in many instances the scraping was intense that the metal surfaces below the paints were exposed. The same instinct of the bees of collecting paints, being deceived by its colour, was again observed on labels kept for drying after painting. To ascertain whether the attraction was simply for the yellow colour, glass slides painted freshly with white, yellow and green and another set of slides completely dry after painting with the same colours were kept near a dammer bee colony entrance in a crevice and it was found that all colours other than wet yellow were ignored by the insects.

It was felt that the paints so loaded in the pollen baskets might be difficult to be dislodged and hence the possibility was more for the concerned bee to fall a victim to the persistant contact action of the paint and its solvents. There was also the danger of the dislodged paints getting mixed with the wax, resin etc., used for comb construction proving lethal to the whole community. The feasibility of the same being mixed with honey as a normal mixture with pollen for feeding the grubs also could not be ruled out, even though the anxiety might appear as an exaggerated one now.

Therefore further observations were conducted to find out what really happened to the bees collecting paints. Only a very few were found dead in the vicinity of the painted boards and all of them had tinges of paints on their limbs. On opening up of a colony within the crevices of a wooden frame, where the paints collecting bees frequented, comparatively large numbers of workers were found dead and the pollen baskets had heavy masses of paints in these cases. However, there were no signs of mixing up of these paints with the wax inside, indicating that the bees could not dislodge the paints gathered by them and all of them fell victim to the paints.

This phenomenon is very significant which leads the bees to self-destruction. To safeguard these productive insects, field labels should

be painted and dried well if yellow colour is to be used, where these bees are known to exist.

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26. ECOLOGICAL NOTES ON THE INDIAN FRESHWATER MICROTURBELLARIA: *MESOSTOMA* SP.

While the taxonomy and distributional ecology of the freshwater and land planarians (Triclad turbellarians) of India have been studied in some detail by Whitehouse (1913, 1914, 1919), Kawakatsu (1969), Kawakatsu & Basil (1971), the freshwater microturbellarians are meagrely known. The purpose of this short paper is to present the results of an ecological investigation into the occurrence of *Mesostoma* species in the vicinity of Madurai in south India. The material was obtained by us from several localities during the course of the collection of freshwater planarians described in a previous paper (cf. Kawakatsu & Basil 1971, pp. 41-42).

Order NEORHABDOCOELA
Suborder Typhloplanoida
Family MESOSTOMIDAE
Genus *MESOSTOMA* Ehrenberg 1936

Mesostoma sp.

External Features: A small and oval-shaped species. Live animals *c*. 2 mm in length and 1 mm in width. The body shows a green coloration. Pharynx is located near the anterior end of the body.

Localities I and II:

The animals were obtained from two temporary granite quarry pools located in front of the buildings of Madurai University, Palkalai Nagar Campus (about 13 km west of the city of Madurai). Both pools have elevated boundary and are exposed to sunlight. The pools are irregular in shape (Loc. I, 345 cm × 148 cm; Loc. II, 223 cm × 195 cm) and contain muddy, greenish water due to the presence of freshwater green algae. The first pool has a depth of *c*. 18 cm at its centre (average depth of 15 cm) and the second pool has a depth of *c*. 12 cm at its centre (average depth 8 cm). The bottom of the pools is muddy and without any large aquatic plants. At the time of the collection of the animals (July 1973) the pools were almost dry. The animals were present only at the edges of the pools.

TABLE

RESULTS OF PHYSICO-CHEMICAL ANALYSIS OF WATER FROM THREE LOCALITIES

Date	Time	Temperature (°C) Air Temp.	Water temp.	pH	Trans-parency (cm)	Dissolved oxygen (mg/l)	Carbon dioxide (mg/l)	Alkalinity ppm ($CaCO_3$)
				Locality I				
21-vii-'73	9.40 (Sunlight clear)	35.0	32.0	7.8	Nil	7.52	7.92	394
	12.40 (Sunlight clear)	39.5	40.0	8.2	Nil	14.35	1.98	390
	15.40 (Cloudy and breezy)	31.5	33.5	8.1	Nil	2.57	2.64	310
				Locality II				
21-vii-'73	9.50 (Sunlight clear)	36.0	33.5	7.9	Nil	7.52	5.28	348
	12.50 (Sunlight clear)	39.5	41.0	8.0	Nil	2.92	4.62	262
	15.50 (Cloudy and breezy)	29.5	31.8	8.2	Nil	1.53	3.52	250
				Locality III				
25-vii-'73	10.00 (Sunlight clear)	35.0	30.0	8.6	33	7.90	0.792	152

The data of the physico-chemical analysis of water taken from the pools I and II are given in the Table. The samples of water were taken from 9.40 to 15.50 hrs at 3 hour intervals. It will be seen from the table that the water temperature of the pools was extremely high and that of the edge area is less than in the centre of the pools. This may be due to constant movement of the shore water by wind action. It is highly probable that this slightly lower temperature may be the reason for the animals congregating at the edge of the pools.

Dead bodies of other aquatic small organisms at the edges of the pools were found to be completely covered by the *Mesostoma* microturbellarian. Laboratory observations showed that the specimens of *Mesostoma* species were attracted towards the flesh of aquatic organisms (such as fish, tadpole and mosquito larvae) and have a habit of completely surrounding the small bits of tissues and feeding on it.

Locality III:

The third pool had comparatively more water that the two pools described above (Localities I and II). This pool located near the localities I and II, is also a granite quarry pool and is similarly exposed to sunlight. The irregular shaped pool (630 cm × 320 cm) contains clearer water with a depth of about 39 cm at its centre and a muddy bottom. The animals were found all over the pool.

The physico-chemical conduction of the water of this pool was observed only at 10.00 hrs (Table). The water temperature of the pool was same in all parts of the pool (30°C).

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27. OCCURRENCE OF *OPHIOGLOSSUM FIBROSUM* SCHUM. AT JUNAGADH IN SAURASHTRA

A few species of *Ophioglossum* have been recorded by Blatter and d'Almeida' from Bombay Presidency.

Recently we obtained *Ophioglossum fibrosum* Schum. growing wild along the foot of the Girnar hills in open areas with grass and small herbs during 1st and 2nd week of July and lasts till September. In October only stray plants are available. Fertile spikes mature during August and September. Each plant has 2-3 fertile leaves on a broadly conical corm having many root fibres. The height of the plants from corm to the top of the fertile segment is from 2 to 3.5 cm.

The species is recorded for the first time from Junagadh as well as from Saurashtra. The specimen is deposited in the herbarium, No. 1250, in Biology Dept. of Bahauddin College, Junagadh.

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28. THE STATUS OF GENUS *PHAULANTHUS* RIDLEY (MELASTOMATACEAE)

The genus *Phaulanthus* Ridl. is reduced to a synonym of *Anerincleistus* Korth. Following are the new combinations: *Anerincleistus acuminatissimus* (Ridl.) Nayar, *Anerincleistus rudis* (Ridl.) Nayar, *Anerincleistus brevidens* (Craib) Nayar, *Anerincleistus pedunculatus* (Craib) Nayar.

Korthals (1840-44) established the genus *Anerincleistus* on the basis *Anerincleistus hirsutus* from G. Malintang, Sumatra. Naudin (1851) and Miquel (1855) accepted Korthal's generic conception of *Anerin-*

cleistus and Triana (1871) effectively published J. D. Hooker's two species *Anerincleistus helferi* Hook. f. and *A. griffithii* Hook. f. both from Burma. Ridley (1911) proposed the genus *Phaulanthus* for those species of *Anerincleistus* having shortly peduncled or almost sessile axillary cymes. The type species which Korthals assigned to the genus *Anerincleistus* is not a species with many flowered panicles. In this genus there is a gradual series from a peduncled condition through shortly peduncled to a subsessile condition. Species with obvious peduncled to a subsessile condition. Species with obvious peduncles are *A. hirsutus* Korth. *A. macranthus* King, *A. hispidissimus* (Ridl.) Nayar; shortly peduncled species are: *A. kinabaluensis* Nayar; species with subsessile peduncles are: *A. helferi* Hook. f., *A. griffithii* Hook. f., *A. fasciculatus* Nayar. In *A. clemensii* Nayar it is seen that the inflorescence is either shortly pedunculate or subsessile. Hence the length of the peduncle and the position of inflorescence have no generic value and it is here proposed to reduce Ridley's *Phaulanthus* to the synonymy of *Anerincleistus*. To a great extend Ridley's proposal for the establishment of the genus *Phaulanthus* primarily based on the length of the peduncle and the position of the inflorescence was due to the wrong asignment of the following taxa to *Anerincleistus*:- *A. sublepidetus* King, *A. beccari* Cogn., *A. cordatus* Stapf, *A. glomoratus* King, *A. monticolus* W. W. Smith which have long paniculate terminal inflorescences.

Anerincleistus Korthals in Temminck, Verhand. Nat. Gesch. Bot. 250, t. 68 (1844).

Phaulanthus Ridl. in Journ. Roy. As. Soc. Straits Br. 57:41 (1911). Synon. nov.

Anerincleistus acuminatissimus (Ridl.) Nayar comb. nov.

Phaulanthus acuminatissimus Ridl. in Kew Bull. 1946:33 (1946). Distribution: Sarawak. Mt. Trekan, alt. 333 m., Hose 640 (Type K); Additional material: Kapit, upper Rejang river, *J. & M. S. Clemons* 21144 (K).

As commented by Ridley (l.c.) in his type description "this species is chiefly conspicuous for its very long acuminate leaves. This is allied to *Anerincleistus pedunculatus* (Craib) Nayar, but differs in having long acuminate leaves and in the orientation of main nerves.

Anerincleistus helferi Hook. f. ex Triana in Trans. Linn. Soc. 28: 75 (1871); C. B. Clarke in Hook. f. Fl. Brit. Ind. 2:529 (1879); Cogn. in DC., Monogr. Phan. 7:478 (1891).

Phaulanthus helferi (Hook. f. ex Triana) Ridl. in Journ. Roy Soc. Str. Br. 57:42 (1911); Ridley, Fl. Mal. Pen. 1:777 (1922). *synon. nov.*

DISTRIBUTION:

Burma. Mergui, *Helfer* (Herb. E. Ind. Comp.) 2304 (Type K); Tenasserim, alt. *c.* 200 m, 5 Jun. 1932, Kerr 21670 (K, BM).

Anerincleistus griffithii Hook. f. ex Triana in Trans. Linn. Soc. 28:75 (1871); C.B.Cl. in Hook. f. Fl. Brit. Ind. 2:529 (1879); Cogn. in DC., Monogr. Phan. 7:478 (1891).

Phaulanthus griffithii (Hook. f. ex Triana) Ridl. in Journ. Roy. As. Soc. Str. Br. 57:42 (1911). *Synon. nov.*

DISTRIBUTION: *Burma.* Mergui, Griffith 2304 (Type K); Ibid., *Griffith* s.n. (K).

This is closely allied to *A. helferi* but differs in having velutinous tomentum in the branches and leaves, and shorter pedicel and smaller calyx tube. *A. griffithii* is related to the bornean species nerves arise from the base of the leaf; whereas in *A. clemensii* the leaf base is cuneate and of the five main nerves two arise 1-1.5 cm above the base of the leaf. Besides *A. clemensii* has glabrous upper surface and velutinous lower surface of the leaf; whereas *A. griffithii* has velutinous tomentum on both surfaces of the leaf.

Anerincleistus curtisii Stapf in Kew Bull. 1892. 196 (1892); King in Journ. As. Soc. Beng. 69:(2) 17 (1900). (Curtis 412-Holotype K). *Phaulanthus curtisii* (Stapf) Ridley, in Journ. As. Soc. Str. Br. 57:44 (1911); Ridley, Fl. Mal. Pen. 1:777 (1922). *Synon. nov. Anerincleistus scortechinii* King in Journ. As. Soc. Beng. 69: (2) 16 (1900). (Scortechini s.n. Lectotype K).

DISTRIBUTION: Malaya. Penang. sine loc. *Curtis* 412 (K); Perak. sine loc. *Scortechinii* s.n. (K); sine loc. *Scortechinii* 31 (K, BM); Larut hills alt. 1000 m, *Curtis* 3715 (K); Taipeng, Aug. 1909, Ridley 14680 (K, BM).

Ridley (1911) appropriately reduced *A. scortechinii* to a synonym of *A. curtisii* Stapf. This is an endemic species having small flowers in axillary pedunculate cymes.

Anerincleistus pauciflorus Ridley in Journ. As. Soc. Str. 54:41 (1910); Ridley Fl. Mal. Pen. 1:776 (1922).

DISTRIBUTION: Malaya. Selangor. Klang Gates, *Ridley* 13522 (Holotype K, Isotype BM); Ginting Bidai, *Ridley* 7323 (K); Ulu Langat, 1 Oct. 1959, *Millard's collector* (K.). Klang Gates., 12 Nov. 1953, *Sinclair SFN* 40137 (L); Negri Sembilan: Bukit Iangga, *Ridley s.n.* (K).

Anerincleistus pauciflorus Ridl. var. **brevipedunculus** Nayar var. nov.

A typo speciei differt pedunculis brevis 6-8 mm longis.

DISTRIBUTION: Malaya. Selangor: Ginting Simpah, alt. 666 m, 28 Oct. 1937, *Md. Nur.* s.n. (Holotype K); Gaombak, 6 Nov. 1930, *Symington* 24331; Ibid., 2 Jul. 1929, *Symington* 18163 (K); Ibid., 6 Oct. 1930, Symington 24452 (K). *Borneo*. Sarawak. Oxford Univ. Expedition to Sarawak 1932: label without any data.

Anerincleistus rudis (Ridl.) Nayar comb. nov.
Phaulanthus rudis Ridl. in Journ. As. Soc. Str. 57:41 (1911); Ridley, Fl. Mal. Pen. 1:777 (1922).

DISTRIBUTION: Malaya. Selangor, Genting Bedai, *Ridley* 7306 (Holotype K); Ibid., Sungoi, Lalang Kajang, 9 Mar. 1930, *Symington* 22721 (K).

The sterile specimens of this species could be easily mistaken for *Driessenia glanduligera* Stapf. But *A. rudis* could be easily distinguishable by the ventrally inappendiculate and dorsally spurred anther and the absence of glandular hairs; whereas *Driessenia glanduligera* has ventrally biappendiculate and dorsally spurred anther and glandular hairs.

Anerincleistus brevidens (Craib) Nayar comb. nov.
Phaulanthus brevidens Craib in Kew Bull. 1930:316 (1930); Craib, Fl. Siam. Enum. 1:688 (1931). *Kerr* 15888—Holotype K, Isotype BM.
Phaulanthus nervosus Craib in Kew Bull. 1930:317 (1930); Craib in Fl. Siam. Enum. 1:688 (1931). Synon. nov. *Kerr* 17127—Holotype, Isotype BM.

DISTRIBUTION: Siam. Nakawn Sritmarat, Songkla Klawng, alt. 50 m, 22 Jul. 1918, *Kerr* 15888 (K, BM); Puket: Takuapa, Kapong, alt. *c.* 100 m, *Kerr* 17127 (K, BM).

A. brevidens is closely allied to *A. helferi* but differs by the much shorter calyx lobes and spares indumentum. According to Craib (1930) *Phaulanthus nervosus* differs from *P. brevidens* by the presence of prominent transverse nerves on the lower surface of the leaf and shorter pedicels. On studying the types it is seen that the flowers buds in both *P. brevidens* and *P. nervosus* have short pedicels. *P. nervosus* is reduced to a synonym of *A. brevidens.*

Anerincleistus pedunculatus (Craib) Nayar comb. nov.
Phaulanthus pedunculatus Craib in Kew Bull. 1930:317 (1930); Craib in Fl. Siam, Enum. 1:688 (1931).

DISTRIBUTION: Siam, Puket. Ranwng, La-un, alt. *c.* 20 m, 1 Jun. 1929. *Kerr* 16491 (Holotype K, Isotype BM).

This differs from *A. brevidens* in having sparsely tomentose branches and shortly pedunculate inflorescence.

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29. *SYZYGIUM CUMINII* (LINN.) SKEELS VAR. *AXILLARE* COMB. NOV.

Brandis (1906) mentions that a specimen (No. 105) of Bourdillon under *Eugenia jambolana* Lam. is perhaps, a distinct species. Bourdillon (1908; *cf.* 1937) states, 'A somewhat similar tree (to *Eugenia jambolana*) but with thinner leaves and smaller flowers, borne in axillary and terminal cymes, is found in the low country evergreen forests about Kulathurpuzha. It is called *Shen nyaral*. Its fruit is edible. It has not yet been decided if it is a different species or merely a variety of *E. jambolana*.' Gamble (1919), while reviewing the flora of the Presidency of Madras, named it a variety, var. *axillare* Gamble, under the genus *Syzygium* Gaertn., since this species of *Eugenia* has been transferred to the genus *Syzygium*. The synonyms mentioned therein are as follows:

Syzygium jambolanum DC. syn. *Eugenia jambolana* Lam.; *E. caryophyllifolia* Lam. var. *axillare* Gamble.

Skeels (1912), while comparing the material he had with him on *Eugenia* and *Syzygium*, placed *E. jambolana* under *S. cuminii* with the following synonyms:

Syzygium cumini (*i*) (Linn.) Skeels syn. *Myrtus cumini* Linn., *Eugenia jambolana* Lam.

S. jambolanum, which was based upon Lamarck's specific name, is superfluous and illegitimate, as an earlier and validly published specific name is available. Since it is now reduced to a synonym of *S. cum-*

inii, S. jambolanum DC. var. *axillare* Gamble needs a new combination, according to the International Code of Botanical Nomenclature. Hence, this new combination is made:

Syzygium cuminii (Linn.) Skeels (1912) U.S. Dep. Agric. Bull. Bur. Pl. Industr., No. 248:25.

Myrtus cumini(i) Linn. (1753) *Sp. Pl.* 471.

Eugenia jambolana Lam. (1789) *Encyclopédie méthodique. Botanique.*, *3*:198.

E. caryophyllifolia Lam. *loc. cit.*

Syzygium jambolanum (Lam.) DC. (1828) *Prodromus systematis naturals regni vegetabilis, 3*:259.

Eugenia cumini(i) (Linn.) Druce (1913) *Rep. Bot. Exch. Cl. Brit. Isles,* 1914, *3*:418.

E. cumini(i) (Linn.) Merrill (1917) *Interpr. Rumph. Herb. Amboin.* 394. var. *axillare* (Gamble) Tenjarla *et* Kashyapa.

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30. SOME NOTES ON THE DISTRIBUTION, NATURE OF HOSTS AND SYMPTOMS OF A FLOWERING PARASITE, *MACROSOLEN COCHINCHINENSIS* (LOUR.) VAN TIEGH. IN WEST BENGAL

Macrosolen cochinchinensis (Lour.) Van Tiegh. (= *Loranthus cochinchinensis* Lour.) a flowering parasite under Loranthaceae parasitizes a large number of wild and economically important plants in different regions of West Bengal. The slow and steady destructive nature of the parasite causes gradual growth reduction, loss of vigour and timber quality of the hosts. The characteristic symptoms in the hosts are the swelling or formation of small burrs on the stems, which ultimately cause death of the surounding tissues and later the branches. It has been

TABLE 1

Name of the Hosts	Family	Distribution of Hosts	Economic Importance	Type of Infection	Type of Host
1. *Acacia nilotica* (L.) Del. sub. sp. *indica* (Benth.) Brenan	Mimosaceae	Frequently distributed throughout the province	Important for wood	S	R
2. *Acacia linearifolia* A. Cunn. ex Maiden & Blakely	,,	Rarely available in most of the districts	—	S	R
3. *Manilkara zapota* (L.) Vanroyen	Sapotaceae	Cultivated	Fruits	M	C
4. *Aegle marmelos* Corr	Rutaceae	Commonly in all the districts	Sacred plant. Important for fruit & wood	M	C
5. *Artocarpus heterophyllus* Lamk.	Moraceae	Cultivated throughout the province	Fruit and for wood	S	R
6. *Bischoffia javanica* Blume	Euphorbiaceae	Planted in Indian Botanic Garden	—	S	R
7. *Bombax ceiba* L.	Bombacaceae	Very common in the province	Cotton and wood	M	C
8. *Carya arborea* Roxb.	Lecythidaceae	Common in Central Bengal	Medicinal	S	R
9. *Citrus grandis* Osbeck	Rutaceae	Cultivated throughout the province	Fruit	S	R
10. *Dalbergia sissoo* Roxb.	Papilionaceae	Planted for economic use and avenue tree throughout the province	Timber yielding	S	R
11. *Diospyros perigrina* Gurk.	Ebenaceae	Wild throughout the province	—	S	R
12. *Elaeodendron roxburghii* Wt. & Arn.	Celastraceae	Wild in North Bengal	Medicinal	M	R
13. *Ervatamia parviflora* (Decne.) Meizer Dress	Apocynaceae	Planted in gardens	Ornamental	S	R
14. *Ficus bengalensis* L.	Moraceae	Wild throughout the province	Religious plant	S	R

TABLE 1 (Contd.)

Name of the Hosts	Family	Distribution of Hosts	Economic Importance	Type of Infection	Type of Host
15. *Ficus hispida* L.F.	Moraceae	Wild throughout the province	Fruit edible	S	R
16. *Ficus lacore* (Bush.) Ham.	,,	,,	,,	S	R
17. *Ficus religiosa* L.	,,	,,	Religious plant	S	C
18. *Kigelia pinnata* DC.	Bignoniaceae	Planted as avenue tree in drier districts	Avenue tree	S	R
19. *Labramia bojeri* A.DC.	Sapotaceae	Planted in Parmadan forest, 24-Parganas	Avenue tree	S	R
20. *Lannea coromandelica* (Houtt.) Merr.	Anacardiaceae	Wild throughout the province	—	S	R
21. *Mangifera indica* L.	,,	Planted in gardens	Fruits and wood	P	C
22. *Mimusops elengi* L.	Sapotaceae	Wild or planted as avenue tree	Ornamental tree	S	R
23. *Morus alba* L.	Moraceae	Cultivated in drier districts	—	S	R
24. *Sapium sebiferum* Roxb.	Euphorbiaceae	Wild in 24-Parganas	—	M	C
25. *Syzygium jambos* (L.) Alston.	Myrtaceae	Cultivated as avenue tree	Fruits	S	R
26. *Swietenia mahagoni* (L.) Jacq.	Meliaceae	Planted as avenue tree		S	R
27. *Terminalia catappa* L.	Combretaceae	,,		S	R

P = Profuse infection
M = Moderate infection
S = Slight infection
C = Common host
R = Rare host

noted that the intensity of the infection to different host species as well as their distribution in certain regions are variable. The cause for the varied range of pathogenecity and their irregular distribution may be due to local climatic effect on parasitism. It has been observed that the humid zone is rich in parasites whereas dry zone has less parsities. Similarly the industrial belt exhibits reduction of parasitic activity perhaps due to the gases and fumes covering the area. These effects may have bearings on the physiological processes of the germinating seeds on the host species and thereby control the parasitic activity. It has been also recorded that gymnosperms or monocotyledon taxon do not have this parasitic infection.

The observations are summarised in Table 1.

DEPT. OF BOTANY, PABITRANANDA GANGULY
ASUTOSH COLLEGE,
CALCUTTA 700 026.

HABRA, 24 PARGANAS, DULAL PAL
WEST BENGAL,
March 14, 1975.

31. NOTES ON SOME INTERESTING CYPERACEAE OF GUJARAT

During the course of a critical study of the Cyperaceae of Gujarat, we came across a few cyperaceous plants which are either little known or unrecorded for Gujarat. Where the plant was recorded by Cooke (Fl. Pres. Bombay Vol. III. 1958), the name adopted by him is given in parenthesis.

Cyperus polystachyos Rottb.

(*Cyperus odoratus* Linn.)

This plant is listed by Cooke (p. 372) from Gujarat on the authority of Woodrow who collected it from Surat. Blatter (*Journ. Bombay nat. Hist Soc. 19*:162. 1909) has also reported it from Kutch. It is included by Sabnis (*Bull. bot. Surv. India 4*:195. 1962) in his Cyperaceae of Gujarat.

Since the reports of Cooke and Blatter, it has not been reported to occur in Gujarat. One specimen (*G.L. Shah* 10477) from Baroda, kept in the Blatter Herbarium, Bombay as an unidentified *Cyperus,* collected in December 1954, is of this species. The present report thus confirms its occurrence in Gujarat but this herbarium specimen consists of two distinct taxa, which, following Kukenthal (Pfreich. 101:367-370. n. 328. 1936), are varieties *polystachyos* and *laxiflorus.*

Key to varieties

Inflorescence globose, compact head;
spikelets 0.7-1.0 × 0.08-0.1 cm .... *C. polystachyos* var. *polystachyos*

Inflorescence lax umbel; spikelets
2.0-2.5 × 0.15-0.2 cm .... *C. polystachyos* var. *laxiflorus*

Cyperus procerus Rottb.

Collected from margins of Nalsarovar in North Gujarat. Very rare. (*MHP* 62, January, 1970).

Cyperus diaphanus Schrad. ex Roem. & Schult.

(*C. latespicatus* Clke.).

Very rare, found among grasses. (Coteshwar, *MHP* 73; Hampheshwar *YYK* 2655; Sadhli *YYK* 2232).

Fimbristylis alboviridis Clke.

This is a rare species growing among grasses along with *F. bisumbellata* Bub. and *F. dichotoma* (Linn.) Vahl. Its present known distribution is Lunawada (*GLS* 14693), Dediapada (*VKS* 1287) and Dangs (*HS* 19198). All the three species mentioned above, together with *F. podocarpa,* look very similar and are likely to be confused. The following key will be useful to separate them.

Nut prominently striate with 6-8 vertical trabeculate ribs:
- Annual; glumes one-nerved, glabrous, obtuse; nuts 0.1-0.15 cm long .... *F. bisumbellata*
- Perennial; glumes 3-nerved; mucronate, hairy, at least on margins; nuts 0.06-0.08 cm long .... *F. dichotoma*

Nut faintly striate with many vertical trabeculate ribs:
- Glumes cymbiform, much convex on back; nut 8-10 ribbed, not verrucose .... *F. alboviridis*
- Glumes more or less flat; nut distantly verrucose in upper half, 17-20 ribbed .... *F. podocarpa*

Incidentally *F. podocarpa* Nees is only recorded from Dangs (Shah & Suryanarayana in *Journ. Bombay nat. Hist. Soc.* 66:412-414. 1969) for which the correct name is *Fimbristylis dichotoma* (Linn.) Vahl var. *pluristriata* (Clke.) Napper in Kew Bull. 25(3):437. 1971.

Acknowledgement

We are deeply obliged to Prof. P. V. Bole for kindly providing facilities to work in the Blatter Herbarium, St. Xavier's College, Bombay and loaning the specimens for critical study.

Department of Botany,
Sardar Patel University,
Vallabh Vidyanagar,
Gujarat,
October 8, 1974.

M. H. PARABIA
G. L. SHAH

ANNUAL REPORT OF THE BOMBAY NATURAL HISTORY SOCIETY FOR THE YEAR 1974-75

Executive Committee

President

Dr. Sálim Ali, D.Sc., F.N.A.

Vice-Presidents

Mr. R. E. Hawkins
Mr. G. V. Bedekar, I.C.S. (Retd.)

Hon. Secretary

Dr. A. N. D. Nanavati, M.D.

Hon. Treasurer

Mr. J. D. Kapadia, I.C.S. (Retd.)

Member

Secretary, Ministry of Education, Govt. of India

ex-officio

Elected Members

Mr. Humayun Abdulali
Dr. S. R. Amladi, M.D.
Prof. P. V. Bole
Dr. P. J. Deoras
Mr. A. A. Dikshit
Dr. C. V. Kulkarni, M.Sc., Ph.D. (Jt. Hon. Secretary)
Mr. D. J. Panday
Mr. B. B. Paymaster, I.C.S. (Retd.)
Mr. G. S. Ranganathan
Mr. D. E. Reuben, I.C.S. (Retd.)

Advisory Committee

Mr. H. G. Acharya	*Ahmedabad*
Mr. F. C. Badhwar, O.B.E.	*New Delhi*
Dr. B. Biswas	*Calcutta*
Mr. S. Chaudhuri	*New Delhi*
Dr. Chintaman Deshmukh, I.C.S. (Retd.)	*Hyderabad*
Mr. Zafar Futehally	*Bangalore*
Mr. Shivrajkumar Khacher	*Jasdan*
Mr. M. Krishnan	*Madras*
Mr. Duleep Matthai	*New Delhi*
Mr. Ranjit Sinh, I.A.S.	*New Delhi*

HONORARY SECRETARY'S REPORT FOR THE YEAR 1974

Membership

The ordinary membership continues to stagnate below 800 as will be seen from the number of 'paid up' members on the Society's register on the 1*st of January*. The slight fall in 1975 is from the fact that many ordinary members of over 20 years standing compounded their membership to life membership.

	1971	1972	1973	1974	1975
Ordinary Members	703	780	801	770	763

The number of other classes of members are given below:

	1971	1972	1973	1974	1975
Life Members	174	181	187	198	232
Student Members	5	5	9	16	20
Honorary Members	3	3	3	4	4
Forest Department Nominees	78	80	89	90	90

Increase of membership still remains a vital unsolved problem and very little diversification of the Society's activities is possible unless substantial support is available from an increase in membership.

ACTIVITIES

Publications

Three issues of the *Journal* were published during the year. Vol. 70 Nos. 2 & 3 and Vol. 71 No. 1. The issues of Vol. 70 of the Journal were

for August & December 1973 and illustrate the time lag between publication dates and actual production dates which continue to frustrate the editors.

The articles continued to cover a wide range of subjects with emphasis on the ecology, behaviour, and taxonomy of Indian fauna and the taxonomy and regional lists of Indian flora.

Books: During the year the following sales were made:

	Sale	Balance Stock
BOOK OF INDIAN BIRDS	1485	2228
BOOK OF INDIAN ANIMALS	770	2020
SNAKE CHARTS	44	930
PICTURE POSTCARDS	87	Nil
CHECKLIST OF THE BIRDS OF MAHARASHTRA	67	650
GLIMPSES OF NATURE IN INDIA	352 +	
(Complimentary)	105	3111

We have so far not been successful in our efforts to obtain financial assistance for re-printing our out-of-print books on Natural History, particularly SOME BEAUTIFUL ANDIAN TREES, SOME BEAUTIFUL INDIAN CLIMBERS & SHRUBS, BUTTERFLIES OF THE INDIAN REGION, CIRCUMVENTING THE MAHSEER AND OTHER SPORTING FISH, and INDIAN MOLLUSCS.

The 10th Volume of the HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN was published during the year and was released by the Prime Minister, Mrs. Indira Gandhi. The Society sponsored this massive and commendable effort.

The difficulties with the Press (partly due to power failure at Madras) which plagued the journal has also prevented the publication of Mr. Krishnan's book INDIA'S WILDLIFE 1959-70. We hope to publish this excellent volume in 1975.

Centenary Publications: With the Centenary of the Society due in 1983, your committee has been considering useful commemorative publications. Two ideas are currently being considered.:

(a) An Encyclopaedia of Natural History based on concise contributions on various natural history subjects by acknowledged experts in the field.

(b) A CENTURY OF NATURAL HISTORY being a selected compilation with subjectwise comments on current positions of articles on various aspects of Natural History published in the Society's journal in the first hundred years of the Society's existence.

Nature Calendar:

The Society's Nature Calendar continues to be popular and a source of income.

Conservation

The Society continued to take a leading part in the conservation movement in the country through its representatives on the State and Central Wildlife Boards, and through its members on the International Union for Conservation of Nature and Natural Resources, the World Wildlife Fund, and the International Council for Bird Preservation.

Member Activities

It has been possible to involve members in Bombay in local field activities.

Borivli National Park Project: With the assistance of interested members an attempt was made during the year to record the changes in the vegetation, animal life, and other natural phenomena in a small valley in the Borivli National Park close to Bombay. The programme was primarily an exercise in training in scientific observation. The activity is being continued.

Bird Census: A monthly roadside census of birds in the Borivli National Park was organised with the assistance of members. The activity received financial assistance from the Sálim Ali-Loke Ornithological Research Fund. The activity is being continued.

Nature Camp: A camp was organised by members of the staff at the Gir Sanctuary for wildlife observation. Several members from Bombay participated.

Godavari Hike: A pilot survey was made by staff and members to the source of the Godavari to examine the feasibility of hiking along the banks of the river to study the natural history of the river.

Nature Walks: Nature walks were organised in Borivli National Park for birdwatching and for study of the vegetation. A large number of members participated.

Photographic Cell: Amateur nature photographers among the members held meeting to discuss methods and see photographs taken by members.

Research and Field Studies

Sálim Ali-Loke Wan Tho Ornithological Research Fund: The Fund continued to support with a fellowship Mr. V. S. Vijayan, who is investigating the ecological isolation of two sympatric species of bulbuls in the Point Calimere Sanctuary in Tamil Nadu.

A fellowship was awarded to Mr. Reza Khan of Dacca University, Bangladesh. Mr. Reza Khan will study the ecology of the Black-and-Orange Flycatcher an endemic species of the higher elevations of the Western Ghats of Tamil Nadu and Kerala.

The Fund also extended support to the organisation of the monthly bird census at Borivli National Park.

Bird Migration Study: The project was continued with financial aid from the Ministry of Agriculture, Government of India. A summer camp was held at Mahableshwar and interesting recoveries of birds ringed during earlier camps were obtained.

We are continuing to receive recovery reports from Russia of birds ringed in India.

University Department: Mr. P. K. Panicker was awarded the M.Sc. degree of the University of Bombay for his thesis on the "Ecology of Hole-nesting Birds". Mr. B. R. Grubh submitted to the University of Bombay his thesis on the "Ecology of the Vultures of the Gir Forest" for evaluation for the Ph.D. degree of the University.

Study of the Lion-tailed Macaque: Dr. Steven Green of the Rockfeller University commenced his study of the species in the Kalakkad Reserve of Tamil Nadu. Dr. Green's research has the approval and active assistance of the Forest Department, Tamil Nadu, and the officials of the Bombay Burma Trading Corporation, particularly Mr. J. J. Bland, a member of the Society and Group Manager of the complex of Tea Estates of the Bombay Burma Trading Corporation.

Frogs Study: A project for the study of frogs in agricultural ecology with Mr. H. Abdulali as Chief Investigator was submitted to the Indian Council of Agricultural Research.

Environmental Monitoring: Schemes for the monitoring of environmental phenomena on a sustained all-year basis in an evergreen forest at Kalakkad in south India and deciduous forest at Borivli have been submitted to the Government of India.

Thattakkad Survey: Located in North Kerala, the area is exceptionally valuable as an example of plains-level evergreen forest. The area was surveyed by the Curator and Mr. V. S. Vijayan, a doctoral student at the Society, from the viewpoint of environmental monitoring and the establishment of a bird sanctuary.

Kinwat Survey: At the instance of the local member of the Legislative Council, Maharashtra, the natural history potential of the Kinwat Forests in Nanded District, Maharashtra, and their development were the object of a brief survey by the Curator and Dr. S. R. Amladi and Mr. S. R. Nayak, two knowledgeable members of the Society. The suggestions made in their report are being implemented.

Survey of the Gharial at Corbett National Park: The status of the Gharial at the Park was studied by Mr. Andrew Ross of the Smithsonian Institution with the assistance of Mr. S. A. Hussain of the Society and Mr. Romulus Whitaker of the Madras Snake Park.

Mussoorie Survey: A collection of birds, mammals, and reptiles from the Mussoorie area was made by Mr. S. A. Hussain of the Society

and Dr. Robert Waltner of the Kansas University Natural History Museum.

Sloth Bear Status Survey: The position of the Sloth Bear, the only endemic species of bear, is not satisfactorily known. At the instance and on behalf of Mr. Jaffeson of Washington, a study of the current status of the species in India was initiated and a questionaire was circulated to forest officials in the known distribution area of the species.

Study of Pollution: The possibilities of undertaking a survey of the extent of DDT and other pollutant levels in birds and other vertebrates is being considered in collaboration with the Bodega Bay Institute of Pollution Ecology. Arrangements are being made in collaboration with the Forest Departments of Karnataka and Tamil Nadu to collect eggs of fish-eating birds for this purpose.

Mahim Bird Sanctuary: The Honorary Secretary, Jt. Honorary Secretary, the Curator and the Asst. Curator were associated in the Committee set up for developing the area as a Sanctuary and assisted in the listing of birds seen in the Sanctuary during the migratory season.

Reference Collection

During the year 506 specimens were received at the Society.

Mammals	49
Birds	100
Reptiles	148
Amphibians	209

Important additions are:

Birds: Purple Thrush (*Cochoa purpurea*)
Coll: S. A. Hussain
Loc: Dhanantly, Mussoorie.

Amphibians: *Rana formosa*
Rana gammiei
Coll: R. C. Waltner
Loc: Mussoorie

Nature Education Scheme

With the appointment of a new Nature Education Organiser activities of the scheme became more field-activity oriented. In addition to lectures and film shows emphasis is being given to taking children on field outings. An article on bird behaviour by the Nature Education Organiser is included in the Syllabus of Karnataka State.

LIBRARY

During the year 154 books were added to the Library, of which 29 were purchased, 104 donated, and 21 received as review copies for the *Journal*. The total number of books and bound periodicals in the library is over 8000 and includes many rare and out-of-print volumes on Indian natural history. We are grateful to the donors, particularly to the British Council, Mr. Cyrus Adenwalla, and Mr. K. M. Khareghat.

GRANTS AND DONATIONS

The Society acknowledges with gratitude the following grants received for specific purposes:

Rs. 1000/- from Dr. Dillon Ripley, towards the *festschrift*.

Rs. 5000/- from Dr. Hamida Saiduzzafar, for the Sálim Ali-Loke Ornithological Research Fund.

Rs. 5000/- from Dr. Sálim Ali, for the Sálim Ali-Loke Ornithological Research Fund.

Rs. 33000/- from Mrs. Loke Yew, for the Sálim Ali-Loke Ornithological Research Fund.

Rs. 2000/- from Dr. Sálim Ali, for the general funds.

Rs. 6000/- from the World Wildlife Fund, towards general funds.

Rs. 600/- from Mr. S. Chaudhury, for Charles McCann Fund.

Rs. 200/- from K. M. Khareghat, for the Library.

Rs. 200/- from Mr. Paul A. Jones, towards general funds.

PATRON'S VISIT

Mrs. Indira Gandhi, who is a Patron of the Society, paid a visit to the Society's premises on 28 December 1974. She spent nearly an hour seeing the exhibits which had been laid out for her and also visiting the collection rooms. She was accompanied by the Governor and the Chief Minister of Maharashtra and other dignitaries. They were shown round by the President of the Society, Dr. Sálim Ali.

MEETINGS

March: Br. A. Navarro, on "Recording Bird Calls".

April: K. S. Dharmakumarsinhji on "The Gir Forest and its Lions".
F. V. Komaret, on "Fire Ecology and Wildlife".
J. J. Masani, on "Snake Bites and First-aid Treatment".

July: R. Bustard, on "The Future of Indian Crocodiles".

August: R. K. Urban, on "Ethopia and its Birds".
Rodney Jonklass, on "An Underwater Photographic Expedition to the Andamans".

Revenue and Accounts

The financial situation of the Society continued to be unsatisfactory. The year's operation showed a small surplus.

Staff

The Committee wishes to record it appreciation of the willing co-operation of the staff in the activities of the Society.

Acknowledgements

The Committee's thanks are due to Mr. M. J. Dickins who looked after the Society's affairs in the U.K., and to the members and others who gave help in its field projects and other activities.

Registered No. F. 244 (BOM)

BOMBAY NATURAL HISTORY SOCIETY

THE BOMBAY PUBLIC TRUST ACT, 1950

SCHEDULE VIII [VIDE RULE 17(1)]

BALANCE SHEET FOR THE YEAR ENDED 31 *DECEMBER* 1974

FUNDS AND LIABILITIES	Rs. P.	Rs. P.	ASSETS	Rs. P.	Rs. P.
Trust Funds or Corpus:			*Immovable Properties*:		Nil
Life Membership Fund:			*Investments*: (At appropriated value)		
Balance as per last Balance Sheet	75,922.26		50, 8% Convertible Bonds each of Rs. 100/- of Ahmedabad Manufacturing & Calico Ptg. Co. Ltd., fully paid		
Add: Amount received during the year	11,455.50	87,377.76	(Market value Rs. 4,750/-)	2,130.20	
Fixed Assets Funds:			202, 8% Redeemable Bonds each of Rs. 116/- of Ahmedabad Manufacturing & Calico Ptg. Co. Ltd., fully paid		
Balance as per last Balance Sheet	1,24,703.19				
Add: Amount received during the year	262.20				
Add: Value of fixed Assets purchased during the year from Govt. of India grant	6,070.60		(Market value Rs. 20,806/-)	9,982.95	
	1,31,035.99		*Government Securities*: (At cost)		
			3% Conversion Loan 1946/86 of the face value of Rs. 25,000/- (Market value Rs. 15,000/-)	25,000.00	
Less: transferred to Income & Expenditure account on account of depreciation for the year	19,807.64	1,11,228.35	5½% Government of India Loan 2000 of the face value of Rs. 2,000/- (Market value Rs. 1,782/-)	2,000.00	
General Reserve Fund:					
Balance as per last Balance Sheet		34,015.40			
Carried forward		2,32,621.51	Carried forward	39,113.15	

BALANCE SHEET FOR THE YEAR ENDED 31 *DECEMBER*, 1974—(*continued*)

FUNDS AND LIABILITIES	Rs. P.	Rs. P.
Brought forward		2,32,621.51
Building Fund:		
Balance as per last Balance Sheet		9,244.68
Publication Fund:		
Balance as per last Balance Sheet		30,725.00
Other Earmarked Funds:		
(As per schedue 'A')		3,26,565.03
Provision for Capital Losses:		
Balance as per last Balance Sheet		4,528.38
Provision for Depreciation on Investments:		
Balance as per last Balance Sheet		9,266.10
Liabilities:		
For Expenses	1,09,908.77	
„ Advance Subscriptions and Other Advances	2,471.20	
„ Sundry Credit Balances	35,550.37	1,47,930.34
Carried forward		7,60,881.04

ASSETS	Rs. P.	Rs. P.
Brought forward	39,113.15	
Unquoted:		
12 Year National Defence Certificates of the face value of Rs. 3,000/-	3,000.00	
Deposit with:		
M/s. Indian Dye Stuff Industries Ltd., Bombay (against Dr. Sálim Ali-Loke Wantho Ornithological Research Fund)	1,25,000.00	1,67,113.15
Motor Cars, Motor Cycle & Auto Cycle:		
Balance as per last Balance Sheet	45,875.45	
Less: Depreciation during the year	9,175.07	36,700.38
Furniture, Fixtures and Equipment:		
Balance as per last Balance Sheet	78,727.74	
Add: Additions during the year (including Rs. 6,070.60 acquired out of Govt. of India Grant)	6,332.80	
	85,060.54	
Less: Depreciation during the year	10,632.57	74,427.97
Carried forward		2,78,241.50

BALANCE SHEET FOR THE YEAR ENDED 31 DECEMBER, 1974—(continued)

FUNDS AND LIABILITIES	Rs. P.	Rs. P.	ASSETS	Rs. P.	Rs. P.
Brought forward		7,60,881.04	Brought forward		2,78,241.50
			Advances: (Unsecured considered good)		
			To Trustees	Nil	
			,, Employees	105.32	
			,, Others	4,384.10	4,489.42
			Loans: (Unsecured considered good)		70.00
			Stocks:		
			Publications (As inventory taken and certified by the Curator)	55,007.25	
			Process cost of publications	3,325.74	58,332.99
			Income Outstanding:		
			Rent	Nil	
			Interest accrued	8,918.53	
			Supplies and Services	85,137.12	
			Grant Govt. of India 1974-75 (Plan Expenditure)	25,000.00	
			Grant Indian Council of Agricultural Research	10,000.00	
			Grant Indian National Science Academy	3,000.00	
			Grant Govt. of Maharashtra (for 1974-75)	64,722.40	1,96,778.05
Carried forward		7,60,881.04	Carried forward		5,37,911.96

BALANCE SHEET FOR THE YEAR ENDED 31 DECEMBER, 1974—(continued)

FUNDS AND LIABILITIES	Rs. P.	Rs. P.	ASSETS	Rs. P.	Rs. P.
Brought forward		7,60,881.04	Brought forward		5,37,911.96
			Cash and Bank Balances:		
			A) *In current Account with*:		
			1. National & Grindlays Bank Ltd., Bombay	29,118.27	
			2. National & Grindlays Bank Ltd., London (£ 1,086/95)	19,565.10	
			3. Chartered Bank, Bombay	25,198.53	
			In savings Account with: National & Grindlays Bank Ltd., Bombay	351.54	
			B) *In Fixed Deposit with*:		
			1. Bank of India, Bombay (consisting of Rs. 36,000/- of Dr. Sálim Ali-Loke Wantho Ornithological Research Fund and Rs. 3,000/- for Col. Burton's Nature Conservation Fund)	39,000.00	
			2. Chartered Bank, Bombay (Consisting of Rs. 15,000/- of Charles McCann Vertebrate Zoology field work Fund & Rs. 9,000/- for Dr. Sálim Ali-Loke Wantho Ornithological Research Fund)	42,400.00	1,55,633.44
Carried forward		7,60,881.04	Carried forward		6,93,545.40

BALANCE SHEET FOR THE YEAR ENDED 31 *DECEMBER*, 1974—(*continued*)

FUNDS AND LIABILITIES	Rs. P.	Rs. P.	ASSETS	Rs. P.	Rs. P.
Brought forward		7,60,881.04	Brought forward		6,93,545.40
			Income and Expenditure Account:		
			Balance as per last Balance Sheet	67,602.66	
			Less: Surplus as per Income and Expenditure Account	267.02	67,335.64
Total		7,60,881.04	Total		7,60,881.04

The above Balance Sheet to the best of our belief contains a true account of the funds and liabilities and property and assets of the trust as per our report annexed.

Trustees

As per our report annexed
(Sd.) HABIB & CO.,
Chartered Accountants.

(Sd.) A. N. D. NANAVATI,
Honorary Secretary,
Bombay Natural History Society.

(Sd.) C. V. KULKARNI
Honorary Treasurer,
Bombay Natural History Society.

(Sd.) G. V. BEDEKAR,
Chairman, Executive Committee,
Bombay Natural History Society.

BOMBAY, 18*th August*, 1975.

SCHEDULE 'A'

BOMBAY NATURAL HISTORY SOCIETY
SCHEDULE FORMING THE PART OF THE BALANCE SHEET AS AT 31 *DECEMBER*, 1974

Name of the Fund/Grant	*Balance as per last Balance Sheet*	*Additions/ Amounts received during the year*	*Transfers from other Funds*	*Total of columns 2,3, & 4*	*Spent/ returned during the year*	*Transfers to other Funds*	*Total of columns 6 & 7*	*Balance as at 31st December, 1974 (5minus8)*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
(1) Field Work Fund (Sir Dorabjee Tata Trust)	2,587.64	—	—	2,587.64	945.00	—	945.00	1,642.64
(2) Staff Welfare Fund	2,020.69	—	—	2,020.69	—	—	—	2,020.69
(3) Dr. Sálim Ali-Loke Wantho Ornithological Research Fund	1,70,136.52	43,000.00	—	2,13,136.52	—	—	—	2,13,136.52
(4) Col. Burton's Nature Conservation Fund	3,021.65	253.69	—	3,275.34	—	—	—	3,275.34
(5) Grant from California Academy of Sciences for Herpetological Survey	296.17	—	—	296.17	296.17	—	296.17	—
(6) Charles McCann Vertebrate Zoology field work fund	15,491.10	1,674.87 (including interest Rs. 1,074.87)	—	17,165.97	—	—	—	17,165.97
(7) Grant from Seth Purushottamdas Thakoredas & Divaliba Charitable Trust for the publication of Mr. M. Krishnan's Ecological Survey of India	6,331.44	—	—	6,331.44	129.90	—	129.90	6,201.54
Carried forward	1,99,885.21	44,928.56	—	2,44,813.77	1,371.07	—	1,371.07	2,43,442.70

Brought forward	1,99,885.21	44,928.56	—	2,44,813.77	1,371.07	—	1,371.07	2,43,442.70
(8) Grant from Smithsonian Institution for the Secretarial Assistance to Dr. Sálim Ali, on the publication of the Birds of India and Pakistan in 10 volumes.	26.57	—	—	26.57	26.57	—	26.57	—
(9) Grant from Smithsonian Institution for Bird Migration Study project	1,356.21	—	—	1,356.21	1,356.21	—	1,356.21	—
(10) Grant His Majesty King of Bhutan for publication of Birds of Bhutan by Dr. Sálim Ali	5,813.39	—	—	5,813.39	—	—	—	5,813.39
(11) Grant from World Wild Life Fund for the publication of a booklet on conservation	3,024.58	—	—	3,024.58	—	—	—	3,024.58
(12) Grant from Fauna Preservation Society London, for Leopard Survey project.	259.36	—	—	259.36	161.98	—	161.98	97.38
(13) Scholarship fund under Dr. Sálim Ali-Loke Wantho Ornithoological Research Fund Investment	12,669.88	16,148.79 (interest)	—	28,818.67	13,443.76	—	13,443.76	15,374.91
Carried forward	2,23,035.20	61,077.35	—	2,84,112.55	16,359.59	—	16,359.59	2,67,752.96

Name of the Fund/Grant	*Balance as per last Balance Sheet*	*Additions/ Amounts received during the year*	*Transfers from other funds*	*Total of columns 2,3, & 4*	*Spent/ rcturned during the year*	*Transfers to other Funds*	*Total of columns 6 & 7*	*Balance as at 31st December, 1974 (5minus8)*
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Brought forward	2,23,035.20	61,077.35	—	2,84,112.55	16,359.59	—	16,359.59	2,67,752.96
(14) Grant from Govt. of India for the purchase of steel Specimen cabinets	6,108.86	—	—	6,108.86	6,070.60	38.26	6,108.86	—
(15) Dr. Sálim Ali's 75th Birthday fund	12,595.76	—	—	12,595.76	—	—	—	12,595.76
(16) Grant from Govt. of India, Ministry of Agriculture (Dept. of Agriculture) for the scheme on Indian Migratory Bird Survey project	6,172.09	22,500.00	—	28,672.09	28,672.09	—	28,672.09	—
(17) Grant from Govt. of India, Ministry of Science and Technology for Plan Expenditure	—	33,000.00	38.26	33,038.26	2,055.00	—	2,055.00	30,983.26
(18) Grant from Kansas University for study collections	—	3,357.34	—	3,357.34	3,302.16	—	3,302.16	55.18
(19) Grant from Bodega Bay Institute of Pollution Ecology, for DDT pollution study	—	2,250.84	—	2,250.84	220.58	—	220.58	2,030.26
(20) *Grants from Govt. of Maharashtra*								
1. *Grant for* 1973-74:								
(a) Establishment Expenses	7,335.00	—	—	7,335.00	7,335.00	—	7,335.00	—
(b) Building Maintenance	863.82	—	—	863.82	863.82	—	863.82	—
2. *Grant for* 1974-75:								
(a) For Establishment Expenses	—	54,222.40	—	54,222.40	41,450.28	—	41,450.28	12,772.12
(b) For Building Maintenance	—	6,500.00	—	6,500.00	6,124.51	—	6,124.51	375.49
Total	2,56,110.73	1,82,907.93	38.26	4,39,056.92	1,12,453.63	38.26	1,12,491.89	3,26,565.03

BOMBAY, 18*th* *August*, 1975.

Registered No. F. 244 (BOM)

BOMBAY NATURAL HISTORY SOCIETY

THE BOMBAY PUBLIC TRUST ACT, 1950

SCHEDULE IX [VIDE RULE 17 (1)]

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 *DECEMBER*, 1974

EXPENDITURE		Rs. P.	Rs. P.
To Expenses in respect of Properties:			
Rates, Taxes & Cesses		Nil	
Repairs and Maintenance		10,664.97	
Salaries		Nil	
Depreciation (by way of provision or adjusted)		Nil	10,664.97
,, *Building Maintenance Expenses*: (As per contra)			
Met out of the Maharashtra Govt. grant 1973-74		863.82	
Met out of the Maharashtra Govt. grant 1974-75		6,124.51	6,988.33
,, *Establishment Expenses*:			
Salaries including D.A. from Govt. of Maharashtra (As per contra):			
For 1973-74	Rs. 7,335.00		
For 1974-75	Rs. 41,450.28	48,785.28	
Carried forward		48,785.28	17,653.30

INCOME		Rs. P.	Rs. P.
By Rent:			
Accrued		Nil	
Realised		Nil	
,, *Interest*: (Accrued & Realised)			
On Securities	5,110.48		
Less: Income-Tax deducted at source	523.00	4,587.48	
On Fixed Deposits	18,913.86		
Less: Income-Tax deducted at source	1,225.00	17,688.86	
		22,276.34	
Less: Transferred to respective Funds		16,351.35	5,924.99
Carried forward			5,924.99

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 *DECEMBER*, 1974—(*continued*)

EXPENDITURE	Rs. P.	Rs. P.
Brought forward	48,785.28	17,653.30
Salaries including D.A. (Other than above)	78,704.67	
Society's contribution to Staff Provident Fund	3,226.50	
Payment and Provision for Ex-gratia Payment to retired employees	3,616.00	
Postages	3,072.45	
Printing and stationery	6,491.24	
Advertisement	135.40	
Telephone charges	1,273.03	
Bank charges	620.32	
Meeting expenses including talks, film shows etc.	2,612.46	
Conveyance and travelling	1,040.30	
Motor Car charges (less recoveries Rs. 550.00)	934.55	
Legal Expenses	500.00	1,51,012.20
,, *Audit Fees*:		1,000.00
To *Amounts Written off*:		
(a) Bad debts	439.64	
Carried forward	439.64	1,69,665.50

INCOME	Rs. P.	Rs. P.
Brought forward		5,924.99
,, *Donations*:		
In cash	9,692.35	
Less: Transferred to Fixed Assets Fund	262.20	9,430.15
Towards Specific Funds:		
1. Dr. Sálim Ali-Loke Wantho Ornithological Research Fund	43,000.00	
2. Charles McCann Vertebrate Zoological field work fund	600.00	43,600.00
Carried forward		58,955.14

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 DECEMBER, 1974—(*continued*)

EXPENDITURE	Rs. P.	Rs. P.
Brought forward	439.64	1,69,665.50
(b) Loan Scholarships	—	
(c) Irrecoverable rent	—	
(d) Other Items	—	439.64
„ *Miscellaneous Expenses*:		
General charges	2,163.93	
Insurance premium	169.95	
Interest on overdraft account	141.66	
Repairs to Furniture and equipment	692.25	
Printing of Society's prospectus	470.00	3,637.79
„ *Depreciation*:		
On Furniture and Equipment	10,632.57	
On Motor Cars, Motor Cycle & Auto Cycle	9,175.07	19,807.64
„ *Expenses on Object of the Trust*:		
(A) *Educational*:		
From respective funds (As per contra)		
(1) Scholarships for field work (Out of Field Work Fund)	945.00	
(2) Expenses on Herpetological Survey (Out of grant from California Academy of Sciences)	296.17	
Carried forward	1,241.17	1,93,550.57

INCOME		Rs. P.	Rs. P.
Brought forward			58,955.14
By Grants:			
(*a*) *Government of Maharashtra*:			
1. for 1974-75 Establishment Expenses		54,222.40	
2. for 1974-75 Building Maintenance		6,500.00	
3. for 1974-75 Educational Activity		4,000.00	
(*b*) *Government of India*: Dept. of Science & Technology			
1. For Journal printing expenses 1974-75		10,000.00	
2. *For Plan Expenditure* 1974-75:			
For Journal Ptg. Expenses	17,000.00		
For other plan Expenses	33,000.00	50,000.00	
(*c*) *Government of India*: Ministry of Agriculture, (Dept. of Agriculture) for scheme on Indian Migratory Bird Survey project 1974-75		22,500.00	
Carried forward		1,47,222.40	58,955.14

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 *DECEMBER,* 1974—(*continued*)

EXPENDITURE	Rs. P.	Rs. P.	INCOME	Rs. P.	Rs. P.
Brought forward	1,241.17	1,93,550.57	Brought forward	1,47,222.40	58,955.14
Expenses on Objects of the Trust: (*contd.*)			(*d*) Indian Council of Agricultural Research, for printing Journal expenses 1974-75	10,000.00	
(3) Expenses relating to Secretarial Assistance to Dr. Sálim Ali for the publication of Hand Book of the Birds of India and Pakistan in 10 volumes. (Out of the grant from Smithsonian Institution)	26.57		(*e*) Indian National Science Academy for Journal Ptg. expenses 1974-75	3,000.00	
(4) Expenses on Bird Migration Study project (Out of the grant from Smithsonian Institution)	1,356.21		*Other Specific Funds*:		
(5) Expenses on Leopard survey project (Out of the grant from Fauna Preservation Society, London)	161.98		1. Kansas University for study collections	3,357.34	
			2. Bodega Bay Institute of Pollution Ecology for DDT pollution study	2,250.84	1,65,830.58
(6) Expenses on scheme of Indian Migratory Bird Survey (out of the gran t from Govt. of India, Ministry of Agriculture, Dept. of Agriculture)	28,672.09		*By Income from Other Sources*:		
(7) Expenditure towards Research Scholarships and other expenses on Ornithological research (out of scholarship fund under Dr. Sálim Ali-Loke Wantho Ornitho-			Membership Subscriptions	33,380.91	
			Student Membership Subscriptions	400.00	
			Subscribers to Journal (non-members)	10,135.51	
			Entrance Fees	715.00	44,631.42
Carried forward	31,458.02	1,93,550.57	Carried forward		2,69,417.14

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 DECEMBER, 1974—(continued)

EXPENDITURE	Rs. P.	Rs. P.
Brought forward	31,458.02	1,93,550.57
logical Research Fund Investment)	12,943.76	
(8) Expenses on publication of Shri. M. Krishnan's book on Ecological Survey of India. (Out of grant from Seth Purushottamdas Thakoredas & Divaliba Charitable Trust)	129.90	
(9) Expenses on purchase of plastic trays for specimen cabinets. (Out of Govt. of India, Dept. of Science & Technology grant)	6,070.60	
(10) Expenses on Field staff salaries (Out of grant from Govt. of India, Dept. of Science & Technology for Plan expenditure)	2,055.00	
(11) Expenses on study callections (out of funds received from Kansas university)	3,302.16	
(12) Expenses on DDT pollution studies (out of funds received from Bodega Bay Institute of pollution Ecology, U.S.A.)	220.58	
Carried forward	56.180.02	1,93,550.57

INCOME		Rs. P.	Rs. P.
Brought forward			2,69,417.14
„ *Publications*:			
Journal Sales		5,036.70	
Profit on Sale of Books:			
Book of Indian Birds		8,876.05	
Book of Indian Animals		12,234.38	
Identification of poisonous snake charts		220.00	
Picture postcards		237.00	
Other publications		3,046.65	
Nature Calendars		26,975.24	
		56,626.02	
Add: Profit on packing charges		11.18	56,637.20
„ *Miscellaneous Receipts*:			
Income Tax refund	1,877.00		
Less: Transferred to respective Funds	1,126.00	751.00	
Library fines		12.50	
Fees for the use of Society's transparencies		6,326.49	
Other receipts		4,376.63	11,466.62
Carried forward			3,37,520.96

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 DECEMBER, 1974—(continued)

Expenditure		Rs. P.	Rs. P.
Brought forward		56,180.02	1,93,550.57
To Expenses on Objects of the Trust: (*contd.*)			
(13) Expenses on pongam valley Bird Census trips (out of the scholarship fund under Dr. Sálim Ali-Loke Wantho Ornithological Research Fund Investment)		500.00	
Educational			
(B) Journal Expenses (including expenses for the Indexes printing)		49,216.31	
(C) Nature Walk Expenses		452.07	
(D) Pongam Valley Bird Census field trips	523.77		
Less: met out of Scholarship fund under Dr. Sálim Ali-Loke Wan Tho Ornithological Research fund Investment	500.00	23.77	
(E) Other field trips		122.58	
(F) *Library Account*: Subscriptions to other Societies	2,117.73		
Carried forward		1,06,494.75	1,93,550.57

Income	Rs. P.	Rs. P.
Brought forward		3,37,520.96
,, *Administrative Fees*:		
For handling various project grants during the year debited to respective funds		777.05
By Transfers:		
Depreciation on fixed assets transferred to Fixed Assets Fund	19,807.64	
Expenditure on Establishment and Building Maintenance transferred to Govt. of Maharashtra grant (As per contra)	55,773.61	
Expenditure on other specific objects transferred to relevant funds and grants	56,680.02	1,32,261.27
Carried forward		4,70,559.28

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31 *DECEMBER*, 1974—(*continued*)

EXPENDITURE		Rs. P.	Rs. P.	INCOME	Rs. P.	Rs. P.
Brought forward		1,06,494.75	1,93,550.57	Brought forward		4,70,559.28
Purchase of Books	469.21					
Book binding charges	512.00					
Other Library expenses	96.00	3,194.94				
(G) *Maintenance of Reference Collections*:		1,621.42	1,11,311.11			
Amounts transferred to Reserve or Specific Funds:						
(1) Grants transferred to relevant funds		1,21,830.58				
(2) Donations towards specific funds transferred to relevant accounts in the balance sheet		43,600.00	1,65,430.58			
Excess of Income over Expenditure transferred to Balance Sheet			267.02			
Total			4,70,559.28	Total		4,70,559.28

BOMBAY, 18*th August*, 1975.

As per our report annexed.
(Sd.) HABIB & Co.,
Chartered Accountants.

BOMBAY NATURAL HISTORY SOCIETY

NATURE EDUCATION SCHEME

Receipts and Payments Accounts for the Year ended 31*st December* 1974

RECEIPTS	Rs. P.	PAYMENTS	Rs. P.
To *Balance as at* 1*st January*, 1974:		By Refund of balance with Bombay Natural History Society, on 1st January, 1974	52.10
1. With National & Grindlays Bank Ltd., Bombay on current account	2,515.07	,, Salary for Nature Education Organiser	7,219.00
2. With Bombay Natural History Society	148.49	,, Printing and Stationery	685.88
,, *Grant Government of Maharashtra*:		,, General charges	1,619.15
For 1973-74	9,236.00	,, Postages	434.05
,, *Sales of Nature Study Booklets*:	252.23	,, Balance as at 31st December, 1974	
		1. With Bombay Natural History Society	252.23
		2. With National & Grindlays Bank Ltd., on Current Account	1,889.38
TOTAL	12,151.79	TOTAL	12,151.79

BOMBAY, 18*th August*, 1975.

As per our report annexed.
(Sd.) HABIB & Co.,
Chartered Accountants.

BOMBAY NATURAL HISTORY SOCIETY

MINUTES OF THE ANNUAL GENERAL MEETING OF THE BOMBAY NATURAL HISTORY SOCIETY, HELD AT HORNBILL HOUSE, SHAHID BHAGAT SINGH ROAD, BOMBAY 400 023, ON THURSDAY, 17TH OCTOBER 1975, AT 6.00 P.M. WITH MR. R. E. HAWKINS, PRESIDENT OF THE SOCIETY, IN THE CHAIR.

FORTY-THREE MEMBERS WERE PRESENT

Agenda Item 1. The Chairman asked the Honorary Secretary to present the Annual Report of the Executive Committee. Copies of the report had already been distributed and reading of the report was dispensed with, with the consent of members present.

While presenting the Report the Honorary Secretary stated that the trend of the membership is not very satisfactory, and appealed to members to make efforts to increase the membership. He made a brief reference to the unsatisfactory financial position of the Society, and stated that we are expecting financial assistance from the Department of Science and Technology, Government of India, for printing our out-of-print publications. The Publications Sub-Committee is considering reprinting the book, *Some Beautiful Indian Trees* from this grant.

Regarding Conservation/Research activity: The Study of the Lion-tailed Macaque by Steven Green has not so far been published, but his report is available in the Society's office for anyone who wishes to read it.

The Honorary Secretary said members would be sorry to learn of the death of Mr. M. J. Dickins, the Society's representative in U.K., on 21st August 1975.

There were no questions and the report having been duly proposed and seconded was adopted unanimously.

Agenda Item 2. The Chairman asked the Honorary Treasurer to present the Balance Sheet and the Statement of Accounts for the year 1974. The cyclostyled copies of these had been distributed for the members' persual.

After presentation of the Balance Sheet, Mr. Humayun Abdulali asked a question about the use of transparencies by the World Wildlife Fund, free of charge, which he claimed was in contravention of the Executive Committee's resolution directing the Honorary Secretary not to allow reproduction of the Society's photographs at concessional rates.

The Honorary Secretary replied that one of our main purposes is

furthering interest in natural history, and that we have always encouraged use of our material for educational purposes. The resolution referred to was in regard to concessional rates for commercial use, and had no bearing on the present case.

The Chairman stated that the Publications Sub-Committee has generally considered such questions on merits of the case and no hard-and-fast rule is laid down.

Dr. Vasa raised the question regarding the increase in membership, and felt that such increase in fee would be avoided if our revenues were not lost in this way. Mr. Dikshit supported Dr. Vasa's stand.

Mr. Manchekar wanted to know the quantum of loss to the Society by free use of transparencies in this case. The Chairman drew the attention of the meeting to an item on page 3 of the Income and Expenditure statement for 1974 indicating an income of Rs. 6326.49 from sale of transparency reproduction rights.

The Balance Sheet and Accounts, having been duly proposed and seconded, were adopted.

Agenda Item 3. The Chairman announced that Dr. Sálim Ali being unwilling to accept nomination as President, he had agreed to act as President as an interim measure.

The following Office bearers and Advisory Committee members had been nominated by the outgoing Executive Committee.

President	:	Mr. R. E. Hawkins
Vice-President	:	Mr. G. V. Bedekar
Hon. Secretary	:	Dr. A. N. D. Nanavati, M.D.
Hon. Treasurer	:	Dr. C. V. Kulkarni, M.Sc., Ph.D.

Advisory Committee:

Mr. H. G. Acharya	Ahmedabad
Mr. F. C. Badhwar	New Delhi
Dr. B. Biswas	Calcutta
Mr. S. Chaudhuri	New Delhi
Dr. Chintaman Deshmukh	Hyderabad
Mr. Zafar Futehally	Bangalore
Mr. Shivrajkumar Khacher	Jasdan
Mr. M. Krishnan	Madras
Mr. Duleep Matthai	New Delhi
Mr. Ranjit Sinh	New Delhi

Apart from the gentlemen nominated by the Executive Committee, eight other nominations had been received for the Executive Committee, namely:

(1) Dr. G. De	—	proposed by Mr. R. A. Mondkar and seconded by Mr. S. M. Ketkar.
(2) Mr. H. K. Divekar	—	proposed by Dr. R. N. Kini and seconded by Dr. H. V. Shenoy.
(3) Dr. B. Das Gupta	—	proposed by Mr. C. B. Mehta and seconded by Mr. D. J. Panday.
(4) Mr. Nazir Latif	—	proposed by Mr. Zafar Futehally and seconded by Mr. S. R. Nayak.
(5) Mr. Bansi Mehta	—	proposed by Mr. S. R. Nayak and seconded by Mr. C. B. Mehta.
(6) Mr. S. V. Nilakanta	—	proposed by Mr. Zafar Futehally and seconded by Mr. S. R. Nayak.
(7) Mr. D. J. Panday	—	proposed by Dr. Sálim Ali and seconded by Mr. P. Kannan.
(8) Dr. R. N. Vasa	—	proposed by Mr. S. J. Wadke and seconded by Mr. R. A. Mondkar.

The Chairman stated that it would therefore be necessary to hold a postal ballot as provided for under Rules 32 and 33.

Agenda Item 4. (Other business): The following resolution was moved by Mr. Bansi Mehta:

> "Resolved that the membership of the Bombay Natural History Society be separated from the contribution to the Journal of the Bombay Natural History Society and the members desirous to contribute to the journal be charged such amount as subscription, as to meet the expenses of the journal and the fees of members not contributing to the journal be reduced accordingly".

The resolution was seconded by Mr. C. B. Mehta.

Mr. B. B. Paymaster read out the Society's Rule 18, and stated that it needs to be studied whether such a resolution is permissible. After some discussion the Chairman said that the matter will be considered by the Executive Committee, and Mr. Bansi Mehta withdrew the resolution.

Mr. Manchekar asked whether the Committee has any programme for improving the Society's finances apart from increasing the membership, etc., Dr. Deoras said that a Sub-Committee has been constituted by the Executive Committee to improve the Society's funds, and indicated two directions in which it was working; (1) by reducing the expenses and (2) by seeking donations from industries.

The Honorary Secretary added that the Committee was considering the possibilities of screening the films *The Baobab Tree* donated to the Society by the Smithsonian Institution. He said that volunteers were needed to make a success of such a film premiere and requested mem-

bers to come forward and enrol their friends for this work.

Arising out of this, Mr. Manchekar asked why the Society has not been associated with the showing of the film *King Elephant* sponsored by the World Wildlife Fund. After some discussion, in which Mr. Abdulali joined, the Honorary Secretary said that the picture was first offered to the Society, but we were unable to utilise the offer at short notice. The World Wildlife Fund, having no volunteers to do this sort of work, were able to take the risk of booking the whole theatre at a concessional rate, and selling tickets at a reduced rate to their members. Tickets were also offered to members of the Bombay Natural History Society, many of whom took advantage of the offer.

Prof. Bole stated that for increasing the finances of the Society we have to work together, and he supported the Honorary Secretary's suggestions.

Mr. Divekar wanted to know whether reports of the research and field studies carried out by the Society can be made available to members. He also suggested that the reports could be printed as booklets for sale. He was informed that this was not practicable, as the demand was not adequate to pay for such printing, but that the files were made available to any interested members.

Mr. Divekar asked for information about the Salary and Provident Fund available to the staff. The Honorary Treasurer replied that there are two categories of staff, the Grant-in-aid staff and the Society's staff. As regards the salary, the Honorary Treasurer stated that salaries of both categories have been revised in accordance with the Maharashtra Government scale. An approach has been made to Government for Provident Fund contribution for the Grant-in-aid staff.

Dr. Vasa referred to the letter sent by the staff to members of the Society. The Chairman informed the meeting that an Enquiry Sub-Committee has been formed by the Executive Committee in this regard. Mr. Abdulali asked whether the report of the Enquiry Sub-Committee would be made available to members, and Dr. Deoras asked whether it would be possible to publish it in the Journal. The Chairman stated that the matter will be considered by the Executive Committee.

Mr. Kalsia asked about the complete ban on shooting within the State of Maharashtra and the attitude of the Society's representative on the State Board of Wildlife in the matter. Mr. Abdulali asked what suggestions, if any, had been made by the Society with reference to the amendment of the Central Government's Wildlife Act. The Honorary Secretary replied that he had made, personally, suggestions for amendments. No amendments were forwarded from the Society, as none had been sent to him by the members of the Executive Committee in response to his request.

Dr. Vasa and Mr. Manchekar asked when the World Wildlife Fund

was vacating the premises of the Society. The Chairman replied that vacation has been agreed upon but no date yet been fixed.

The meeting terminated with a vote of thanks to the Chair.

In the postal ballot held on November 1975 the following were elected to the Executive Committee:

EXECUTIVE COMMITTEE

Dr. S. R. Amladi
Prof. P. V. Bole
Dr. B. Dasgupta
Mr. H. K. Divekar
Mr. Lavkumar J. Khacher
Mr. Nazir Latif
Mr. Bansi Mehta
Mr. Kisan Mehta
Mr. S. V. Nilakanta
Mr. D. J. Panday

ERRATA

Volume 72(2): August 1975

Field Guide to the Amphibians of Western India—Part III

On Page 507, para 4, line 10
for "long pinted papilla" *read* "long pointed papilla"
On Page 510, footnote, line 1
for "*In* BOULENGEN" *read* "*In* BOULENGER"
On Page 513, para 1, line 12
for "chukle-like" *read* "chuckle-like"
On Page 515, in line 5
for "from the side small" *read* "from the side of small,"
On Page 517, para 2, line 5
for "On one sides" *read* "on the sides"
On Page 518, para 2, line 3
for "male with sitting" *read* "male while sitting"
for "sylabilised" *read* "syllabilised"
On Page 522, in line 5
for "Burrrowing" *read* "Burrowing"

Miscellaneous Note No. 8—Nomenclature of the Asian Palm Swift

On Page 540, in line 29
for "The history of these"
read "The history of the second of Latham's two sources, i.e. General Hardwicke's drawings,"

THE SOCIETY'S PUBLICATIONS

Mammals

The Book of Indian Animals, by S. H. Prater. 3rd (revised) edition. 28 plates in colour by Paul Barruel and many other monochrome illustrations. Rs. 40
(*Price to members Rs.* 35)

The Ecology of the Lesser Bandicoot Rat in Calcutta, by James Juan Spillett. Rs. 10

Birds

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